VOL. 46 DECEMBER 1920 No. 214

DEC 23 1920

United States Naval Institute Proceedings

The writers only are responsible for the contents of their respective articles

CONTENTS

	PAGE
The Elements of Leadership.—Knox	1883
Steel Tower Construction at the World's Greatest Radio Station.—Copeland	1903
Our Divided Personnel.—Dillingham	1921
Admiral Nearchos.—Wright	1925
A Method of Gun Construction by Radial Expansion.—Brown	1941
Graphical Method for Reducing Latitude Sights to Meridian.—Fay	1971
Rebuilding the Navy's Enlisted Personnel.—Henning	1979
Functions of the Office of Naval Operations.—Castex. Tr. Westcott	1987
Discussion	2001
Secretary's Notes	2003
Professional Notes	2005
Notes on International Affairs	2041
Review of Books	2048
Index to Volume 46	2054
Information Index	2004

Copyright, 1920, by J. W. Conrey, Trustee for U. S. Naval Institute

Entered at the Post Office at Annapolis, Maryland, as Second Class Matter

WORLD'S ONLY MANUFACTURER

Moulded High Frequency—High Tension Insulators and Insulating Parts

INSULATORS, 1,000 TO 1,000,000 VOLTS

INSULATION "MADE IN AMERICA"

ELECTROSE

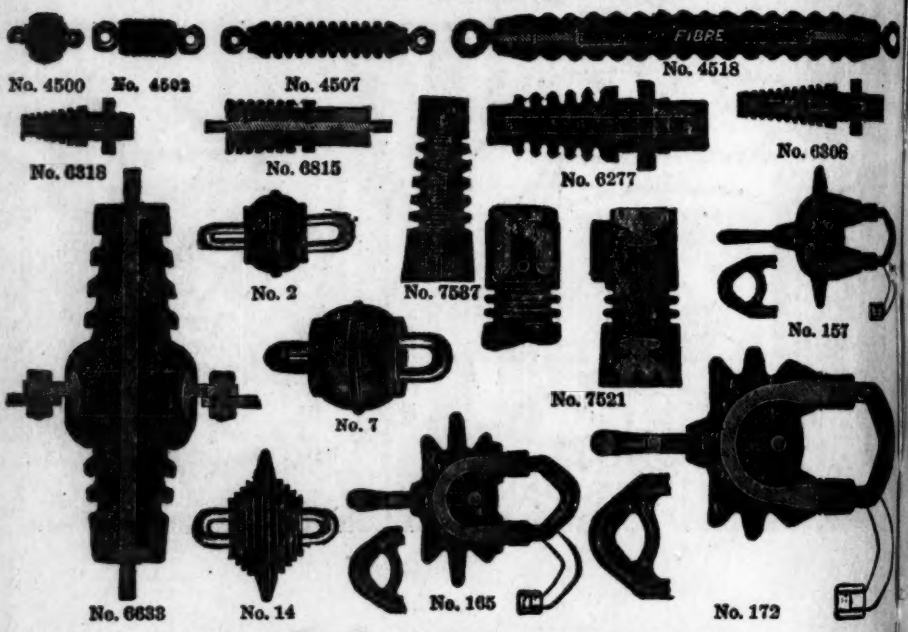
INSULATION "MADE IN AMERICA"

Louis Steinberger's Patents

"ELECTROSE" Insulators are standard with UNITED STATES NAVY and ARMY and WIRELESS TELEGRAPH and TELEPHONE COMPANIES.

"ELECTROSE" is made in a number of grades for various requirements, each grade possessing special characteristics.

"ELECTROSE" INSULATORS—BEST IN THE WORLD FOR HIGH FREQUENCY CURRENTS. POWER AND TRANSMISSION CIRCUITS



"ELECTROSE" STANDARD PRODUCTS

"Arcover" disk strain and suspension line insulators, "Safety Strain" insulators, Disk, Hood, Thimble and Rod type strain insulators, Spool and Bracket-Arm strain insulators, Pin type line insulators, Insulator pins, Roof, Barrier and Wall Bushings and Insulated Connectors, single and multi-part, plain and locking, water and gas tight, Bus-bar insulators, Insulating Supports and Pedestals, Arc Lamp Insulators, Insulating Knobs and Handles, Insulating Sheets, Tubes and Rods, etc., etc.

"Electrose" Railway Line Material:—"Safety Strain" Insulators, Brooklyn Strain Insulators, Insulated Turn-Buckles, Caps and Cones, "Ideal" Locking Caps and Cones, Insulated Bolts, Feed Wire Insulators, Third Rail Insulators, also special forms of Trolley Wire Suspension Insulators, etc., etc. Complete line always carried in stock.

Ignition Insulating Parts:—Distributor Blocks, Disks, Switch Bases, Spools, Brush Holders, Knobs, Handles, etc., etc.

"Electrose" insulation (certain grades) is recognized as the best obtainable for use in connection with insulating parts for ignition service for Automobiles, Aeroplanes, Motor Boats, etc.

Insulators and Insulating Parts and Devices of special sizes and forms, designed and made to order.

Sole Manufacturers

ELECTROSE MFG. CO.

66-82 Washington St. 27-37 York St.
66-76 Front St. 1-23 Flint St.
BROOKLYN, N. Y., AMERICA

Vol. 46, No. 12 December, 1920 Whole No. 214

United States Naval Institute

Proceedings

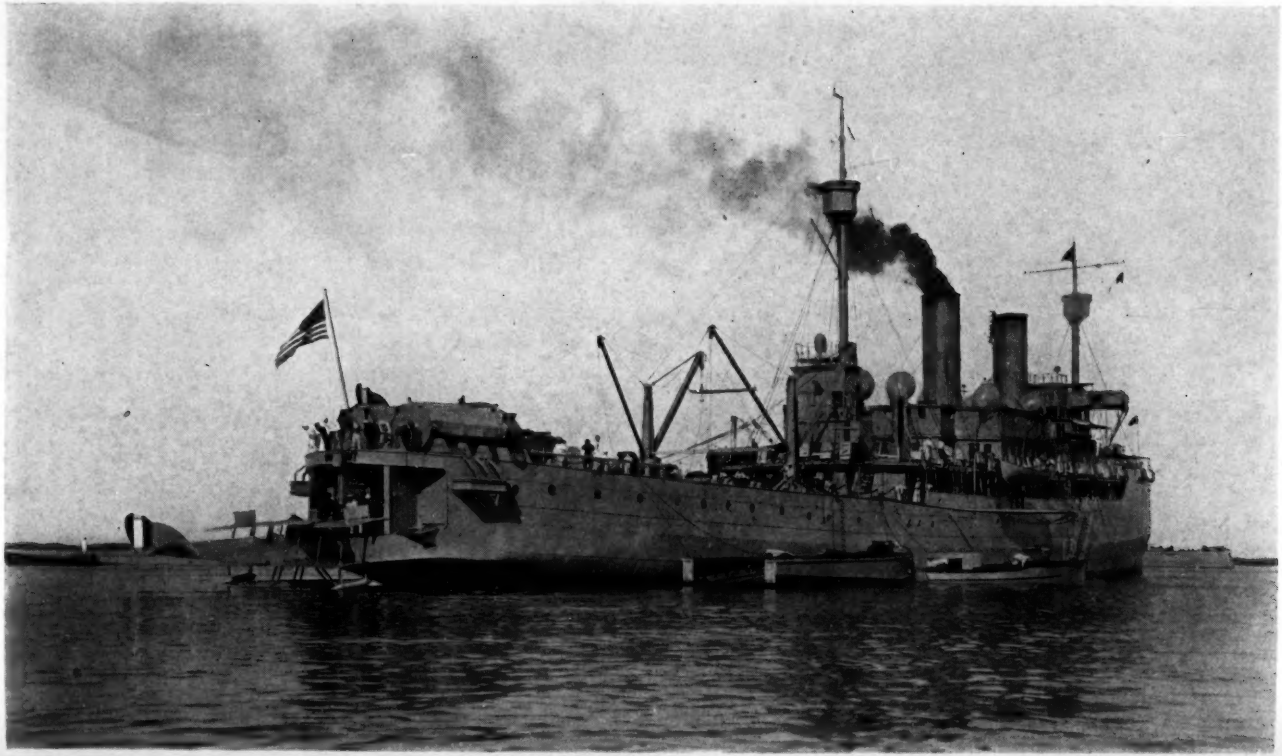
PUBLISHED MONTHLY
EDITED BY H. K. HEWITT

COPYRIGHT, 1920
BY J. W. CONROY
TRUSTEE FOR U. S. NAVAL INSTITUTE

U. S. NAVAL INSTITUTE
ANNAPOLIS — MARYLAND

COPYRIGHT, 1920
BY J. W. CONROY
TRUSTEE FOR U. S. NAVAL INSTITUTE

The Lord Baltimore Press
BALTIMORE, MD., U. S. A.



U. S. S. SHAWMUT

UNITED STATES NAVAL INSTITUTE PROCEEDINGS

Vol. 46, No. 12 DECEMBER, 1920 Whole No. 214

[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE ELEMENTS OF LEADERSHIP[1]

By CAPTAIN DUDLEY W. KNOX, U. S. Navy

In its broadest sense Leadership encompasses the entire profession of the officer; and is virtually synonymous with officership. But we are not here concerned with those aspects of the subject pertaining to "higher command." In a more restricted, and probably a better technical sense, Leadership relates primarily to the *handling of subordinates;* which is the paramount function of officers. Even in the multifarious duties connected with material, the officer's primary rôle is the handling of men who manipulate the material.

The practice of any art is facilitated greatly by knowledge of and skill in related arts. The dentist must know something of medicine and surgery; the seaman and the aviator require familiarity with meteorology, etc. So it is with Leadership. The leader of men is handicapped seriously without a good working knowledge of such arts as organization and administration. This is a necessary foundation for Leadership. Moreover, proficiency in leading men, as in all other forms of human endeavor, is immensely furthered by a knowledge of the governing principles. Once principles are mastered, sound practice follows inevitably. Ignorance of principles limits and retards tremendously the development of proficiency; it compels the practical man to grope

[1] Lecture delivered at the Staff College, Pacific Destroyer Force, Rear Admiral H. A. Wiley, Commanding; August, 1920.

U. S. S. SHAWMUT

and flounder; to learn only through laboriously repeated experience, which he can analyse and profit by only with much difficulty and serious waste of time. Principles serve as a compass—a practical means to point the direct course.

For these reasons it is considered that the most practical and helpful method of treating our subject is primarily to formulate principles; and then to give such consideration to their application as time will permit.

PRINCIPLE I. A LEADER MUST EXERCISE CONTROL OVER HIS SUBORDINATES

This is the basic principle; the need for which is too well understood to require argument. What concerns us here is how to get this control. In the navy, law and regulations provide ample authority for duly constituted leaders. But unless such authority is actually exercised, it is valueless. How often have we seen young officers and petty officers virtually impotent because they knew not how to exercise the authority which was theirs? Occasionally even old officers are seen who have failed to develop in themselves sufficient capacity for Leadership, and hence are unable to use their authority effectively and to control properly their subordinates.

To a great extent control over men is influenced by the leader's "military character," which will be discussed later. Organization is another important element, more especially as the number of men increases. But the basis of control is *discipline*. Subordinates must obey if the fundamental purposes of a military organization are to be accomplished.

Punishment is usually associated prominently with discipline. It is more logical to link it with indiscipline. The need for excessive punishment, in degree or frequency, is certain evidence of bad discipline; which can be corrected best, not by punishment as a primary agency, but by good morale established by a type of Leadership in which punishment plays a minor rôle.

On quiescent occasions the specter of punishment, however sorry a substitute it may be for good morale, may be adequate to obtain satisfactory obedience. But in battle, or other emergency—such as "man overboard," fire, collision, etc.—the mere ability to obtain obedience, through either fear or good will, is not

sufficient; at such times of crucial test, obedience must be prompt to an extreme, *virtually instinctive,* if panic, failure, loss of life, or defeat, are to be averted and success achieved.

Instinctive obedience in crises cannot be obtained without enlisting the aid of *habit;* because under unusual mental tension the average mind escapes the ordinary rule of the will, and *habits* alone dictate conduct. However important the function of drills in promoting mechanical efficiency, such effect is of less value than of instilling a *habit* of *obedience.* The officer who fails to exploit this aspect of drills; who permits men to obey leisurely, to answer back, to be slovenly in bearing, etc., may possibly accomplish something towards improvement in mechanical manipulation, but the net result will be positively harmful, owing to the promotion of a habit of indiscipline—a habit which will cost lives in emergencies.

The need for instinctive obedience in order to save life and ships, and to win battles, is the great impelling reason for the ceremonies and conventions of military life; and for general "smartness" of every kind. These tend constantly to create a *habit* of subordination and obedience to proper authority. It may appear to be a stretch of imagination to contend that strict observance of the salute and other minor formalities will play an important part in meeting major emergencies successfully, yet it is a fact; because the habits thus formed by repeated daily observance promote in great measure that control without which disorganization and failure readily occur under stress.

It is said that until the first gas attack the Canadians of all ranks were impatient of and inclined to ridicule these seemingly petty conventions. Their bitter experience then, when a great number of lives were lost unnecessarily through the breakdown of military control, convinced them of the vital importance of tautness in minor military etiquette. Thereafter the Canadians made a fetish of such things and soon became a crack fighting army. The earnestness and thoroughness with which the quickly created American Expeditionary Forces observed the salute and other formalities undoubtedly contributed more than any other single factor in their early readiness for active service, and their excellent showing in battle. There can be little doubt of this fact when we contrast the superb performances of American troops in Europe, with the many disgraceful incidents in American history

of which troops were guilty who scorned the apparent trivialities. When the Bolsheviki abolished the salute, the troops left the trenches and sold their artillery. It was only after the fallacy of their theories had been proved that the Bolsheviki resorted to the harshest discipline in Europe, and began to be successful.

The hand salute, the "sir," the cheery "aye, aye," standing at attention, piping the side, parading the guard, gun salutes, etc., are all marks of respect, subordination and courtesy, of the highest utility in promoting control through habit. It is not a trivial duty that every officer shall himself be punctilious in these matters; nor that he should take sufficient pains to keep others up to the mark. In view of the regulations and well established custom in these conventions, their neglect constitutes an act of indiscipline; which if repeated often will surely lower our cohesion and efficiency in emergencies, through the strong psychological influence of habit. To blink at these things is to train falsely.

On the other hand, there is danger in overdoing etiquette, ceremony and smartness, and of defeating their own ends by reaction. An overdose, psychological or physical, is frequently more harmful than an underdose. It is just as essential *not* to keep men standing at attention without sufficient reason, as it is to do so when proper occasion demands. Subordinates should not be expected, nor required, to salute when engaged in occupations requiring their concentrated attention; nor under unusual circumstances where its omission does not constitute obvious neglect. Tact and a sense of appropriateness are required. When the occasion calls for etiquette and ceremony, habitual and punctilious smartness should be insisted upon; but when they are out of place, informality and relaxation should be provided for just as carefully. The preservation of this balance is a mark of good officership.

The stabilizing influence of habit facilitates greatly the needful control over men's volition. Discipline, built up by habit, furnishes a strong impulse to obey orders from higher authority, when excitement in any form tends to undermine the mental control which men normally exert over their individual actions.

Habit serves the purposes of Leadership control in another way also. Occasions will arise when emotion is so strong as almost to eliminate volition and will power, and men's actions will become largely mechanical. Under such conditions habit will dominate

their actions; they will automatically revert to the mechanical processes to which they have been habituated previously. For example, a well drilled gun's crew, under a fire so heavy as to upset their mental equilibrium, will continue to serve their gun in a purely mechanical way, much longer than will a gun's crew whose drill has been neglected. The mechanical habits established by conscientious drill may become of vital consequence to control in battle. Habit is then doubly essential as a stabilizer for control. It furthers control through discipline, while volition is active, and also through automatism, when actions become merely mechanical.

But when the emergency is great, or emotion from any cause is at its height (when the gun's crew gets panicky), habit alone cannot be relied upon to ensure adequate control; more especially when it becomes necessary to perform some act to which the organization has not been habituated. Under such circumstances a leader may require not only the emergency brake of habit, but also an accelerator; which will be at his command if he is proficient in the art of suggestion, and understands the elements of crowd psychology. Such knowledge will also be useful as an aid to control under normal circumstances.

Both for individuals and crowds the following conditions favor their responsiveness to suggestion:

(a) Highly concentrated attention on one subject.
(b) Monotony of external surroundings.
(c) Restriction of bodily movement.
(d) Fatigue.
(e) Emotional excitement.

If the suggestion to be made is for immediate action, the most effective manner of making it is by example, more especially the example of a recognized leader of high prestige. Oral persuasion or direction is useful, but not so effective as the example of immediate execution.

When the object is not one calling for the immediate action of the crowd, but is to impregnate their minds with beliefs, other means of suggestion are best utilized. Simple affirmation, free from reasoning is very effective; especially if repeated constantly, monotony of repetition being carefully avoided by interspersing a variety of other related ideas. In addressing a crowd the effect of the last impression given is much greater than any previous ones, and this fact should always be utilized.

Psychology is rapidly emerging from the domain of fakirs and becoming more and more the concern of those practical men whose work requires the handling of other men collectively. In these modern times no leader can be considered proficient until he is able to turn to practical account some of the well proven aspects of psychology.

Besides certain attributes of character in the leaders themselves, and good organization, the principle of *control* requires first of all good discipline, in attaining which habit is the most valuable aid; second, sufficient drill and training to induce excited men to perform their respective tasks automatically; and third, facility in utilizing the power of suggestion.

While it is essential that leaders shall establish mental supremacy over their men by the above means, in order to control them properly; it is equally necessary that such domination shall not be so prominent as to incur their constant instinctive resistance. It is much better that the control be achieved almost without the subordinates themselves realizing it. This can be made possible only through a condition of psychological harmony; which will itself react in furtherance of control.

PRINCIPLE II. PSYCHOLOGICAL HARMONY WITHIN AN ORGANIZATION IS INDISPENSABLE TO ITS GENERAL EFFICIENCY

This is the second great principle of Leadership.

Whatever control is enforced over inwardly rebellious men costs undue friction and effort to overcome their hostility; and consequently the efficiency of the work in hand is lessened by the wasted effort involved. But, worse than this, repeated control in spite of covert opposition, forms a pernicious habit of insubordination in those so controlled, which inevitably will prove a serious menace in emergencies.

On the other hand, a condition of psychological harmony is a constant aid to the efficient performance of any task; and whenever such condition is habitual, it furnishes a most valuable means of inculcating instinctive obedience, and of creating the very highest state of discipline and general efficiency.

When we consider the importance of psychological harmony, together with the adverse influences of normal military and naval conditions—such as the surrender of personal freedom, the discomfort, hardship, and danger, and the many other detrimental

circumstances familiar to all—it is apparent that this question requires constant attention, and proficient handling, if the officer is to be a successful leader.

(a) *Justice* in the exercise of authority is a basic element in psychological harmony. This truth is too well understood to require argument here. It is important to note, however, that what counts most in establishing the spirit of harmony is not the *fact* of justice prevailing; but a general *belief* that such prevalence exists. The justice must be obvious to all. Pains must be taken by leaders, without undignified advertising, to establish the conviction among their subordinates that impartial justice is a primary consideration in the exercise of authority over them.

(b) *Understanding.*—As a rule the men and younger officers lack conviction as to the genuine need for many of the apparently minor requirements of military and naval life. Without such conviction these things undoubtedly assume an aspect of imposition and sometimes even of persecution; and cheerful compliance with requirements is then impossible. To couple an excuse or an explanation with every order obviously is to weaken authority and control. Yet if men are kept habitually in ignorance of the purpose of their orders, a great incentive to a cheerful spirit is necessarily lost. They must be kept generally informed of events pertaining to their work and of the intentions of those in authority, if the human interest and good will essential to the best accomplishment are to be aroused and maintained.

Of course it is not always expedient immediately to inform subordinates fully of the reasons for orders. But pains should be taken to do so as early as practicable. Meantime it is of the utmost importance that officers refrain from habitual growling and impugning the motives of higher authority. This is a most pernicious practice which promotes serious misunderstanding and a spirit of mutiny.

Information pertaining to current work is not all that is needed. If men are to submit cheerfully and willingly to our somewhat annoying customs and conventions, they must first be convinced that these troublesome usages play an important and necessary rôle in naval efficiency. The good health of men crowded together on board ship requires scrupulous cleanliness both of person and of habitation. This obvious fact is overlooked by many thoughtless men unless their attention is drawn to it with some frequency;

preferably supported by data. Neatness and orderliness are indispensable to coordinated effort; more especially under crowded conditions and in emergencies. Cleanliness and neatness both stimulate self-respect, without which men and efficiency degenerate rapidly. The rôle of etiquette, form and ceremony of all kinds, in creating and maintaining discipline—the lifesaver in emergencies—is more difficult to make men understand. But the pains needed to explain the underlying reasons for all these matters, so peculiar and inexplicable to the average recruit and even to many others, is more than repaid by the gain in psychological harmony.

Men must understand the objects and reasons for any troublesome effort, if they are to give a whole-hearted response to the demands made upon them.

(c) *Comradeship.*—Probably the most important of all the elements of psychological harmony is a spirit of comradeship. It is the surest antidote to the inevitable enmity felt by men reared in a democracy against what seems to them the despotic leanings of the military services. Strangely enough there has been less comradeship between American officers and men than between those of some European services. During the late war, the principal point emphasized by the British in the training of the large number of new officers was the imperative necessity for their establishing a bond of comradeship between themselves and their men. British practice in this regard perhaps would have a color of paternalism and patronizing that would be objectionable to American men. Nevertheless the principle is sound, and there is every reason why we should apply it; adjusting our methods to suit the conditions confronting us. It is of course very essential to avoid undue intimacy and familiarity, which the men themselves dislike and which experience has shown to be so disastrous to discipline and proper control over men. The requirements of Leadership impose some degree of reserve on the part of seniors and appropriate deference from juniors. When these bounds are overstepped Leadership is undermined; yet if they are too inelastic the consequences are equally detrimental. Good leaders learn and follow a middle course; which is not difficult for officers who have acquired poise, self-possession and *savoir faire,* and who have a fraternal feeling towards their subordinates.

Those who really feel comradeship will give unmistakable evidence of the fact in the numerous ways in which feelings are manifested to others—by bearing, manner, tone, general expression, etc.—ways difficult to define but familiar to all. Officers should strive to foster by their own expression reciprocal feelings towards themselves by the men; and to avoid careless rebuffs to their subordinates, who are apt to be hypersensitive.

An active earnest practical interest in the general welfare of subordinates is essential to feelings of comradeship on their part towards seniors. A good officer will keep an eye on his men's mess, to see that they get good food well served. He will be watchful that excessive work is not required of them without necessary cause; that through accident or design they are not deprived of money, leave and privileges which are their due; that unnecessary discomfort or other aggravating conditions are not imposed upon them; that they are not punished unjustly; that they have adequate opportunity and means for healthful recreation, etc. In these and many other things the officer must exercise foresight and take the initiative to safeguard the general welfare of his subordinates; many of whom through ignorance or diffidence will refrain from making reasonable protests, yet will harbor feelings of dissatisfaction and resentment against annoying circumstances.

Furthermore, a good officer will not hold himself too much apart from his subordinates—be they officers or men. Nothing contributes so much to a proper spirit of comradeship as a degree of sociability; more especially when combined with courtesy, cheerfulness and humor. Subordinates should be talked to, frequently, in a friendly human way, and not treated as though they belonged to a different species. A kindly "good morning" with a few words of personal interest goes a long way towards maintaining a spirit of comradeship.

It is also highly important that a directly personal relationship be established with each subordinate. Each one should feel that this individuality is not submerged into the impersonal mass of the organization; but that his own self is a distinct personality in which his seniors have a direct human interest. The daily work will offer ample opportunities for this; but it can be done most effectively whenever men are in trouble, or desire a special favor. A keen personal interest exhibited at such times solidifies the personal relationship in an amazing way. Such a relationship

makes it possible to handle successfully those with incorrigible leanings, and to command the good will and comradeship of all, to a degree that is otherwise impossible.

(d) *Recreation.*—A reasonable amount of recreation is normally essential to the mental well being and contentment of men; especially when they occupy positions of but little responsibility. It is an important part of a leader's function to provide diversion of a form sufficiently interesting to serve as recreation for their subordinates. The peculiar conditions of military and naval life frequently deny men opportunity for ordinary kinds of recreation, and at times unduly attract their attention to pernicious amusement. A good officer will be active and resourceful in devising and providing means for healthful, interesting recreation for his men, and will encourage their participation in it. Some tact is required on his part in guarding against too much paternalism, or too great a color of officialdom, both of which are distasteful to men in matters of recreation. If the means and opportunity are provided at the men's own suggestion, so much the better; but in any event the officer should keep in the background once any particular form of recreation is well started.

Justice in the exercise of authority, *Understanding* by subordinates of the reasons for the requirements and orders of higher authority, a *Spirit of Comradeship* between all ranks and ratings, and adequate *Recreation,* are four primary factors in the principle of psychological harmony. This principle is closely affiliated with that of control, the first one considered. They afford each other mutual support and furnish a good groundwork for leadership of men. But these are not all of Leadership; otherwise we might be content to command a herd of cows, in which control and psychological harmony are normally developed highly. With organizations of men, idealism or some other kind of inspiration is indispensable, if great achievement is to be counted among their capabilities. This leads us to the third principle.

PRINCIPLE III. SOME DEGREE OF EMOTIONAL INSPIRATION IS ESSENTIAL TO THE HIGHEST EFFICIENCY

The old prejudice against "too much contentment" has its origin in a belief that marked contentment can exist only as the result of slackness, and therefore of inefficiency. There is some ground for this belief; but only in cases where the officers are

deficient in the art of Leadership. With good leaders the most efficient organization is the most contented; a combination accomplished principally through various forms of emotional inspiration, the most important of which will be discussed below.

(a) *Interest* is a great stimulus to effort and achievement. When interest flags efficiency necessarily depreciates. When interest is aroused and maintained at high pitch, capacity for work and for accomplishment is greatly enhanced. A common method of killing interest is by unwarranted interference in the province of subordinate officers and petty officers. Both their province and their pride must be respected if their interest is to be sustained. Many ways of exciting and maintaining interest will suggest themselves to the resourceful leader; but most important of all is for him to exhibit repeated evidence of his personal interest in the endeavors of those under him. The influence of interest upon successful achievement is so great as to require the studied attention of leaders.

(b) *Self-respect* lies at the roots of all the higher instincts, and furnishes a foundation for the kind of inspiration a leader needs to give to those under him. Without a man possess self-respect no appeal to him, except of the most sordid and selfish origin, will awaken any higher response. A military organization composed of such men would surely disintegrate, unless held together by the most iron discipline based on fear and spoils.

It is almost universal practice to stimulate the development of self-respect by requiring men to keep themselves and their surroundings clean and neat; to maintain a smart carriage and manner; and to comport themselves respectably. This has a sound basis in the peculiar psychological principle that what attributes men habitually pretend to have they will actually acquire. Progress is doubtless often slow and imperfect, but nevertheless is real; and when assisted by public opinion and stimulated by the force of example it is usually rapid. Herein we see the reason for the emphasis laid on these seemingly trivial, but really very important, matters in all highly efficient services. Through generations of experience they have learned this fundamental lesson.

All ranks and ratings would doubtless take kindly to the necessarily irksome and constant task of keeping up external appearances, if they appreciated better the genuine need for it. The profound influence of example, and of the opinion of others, in

these matters imposes upon officers the important duty of themselves setting a good example of neatness, smartness and deportment; and of creating general opinion within the service in support of high standards in these respects.

A good leader will studiously avoid assailing the self-respect of his subordinates; by requiring lowering duties of them, by his manner towards them, or in other ways. He will on the contrary seek every means and occasion for developing their self-respect.

The pleasurable feeling of self-satisfaction and the human trait of pride furnish excellent self-respect builders. Praise and reward when merited, if utilized with judgment and moderation, are very useful to increase men's pride and satisfaction in their work and in themselves. It is good practice to be punctilious about giving due credit to men who have performed a special task well. Many other methods of fostering pride and self-respect will suggest themselves in the course of routine duty to officers who desire to make the most out of this method of giving needed inspiration to their men.

(c) *Esprit de corps* is based on collective self-respect; which furnishes a higher form of inspiration than does individual self-respect, because it is less selfish.

The relationship between *esprit* and loyalty is exceedingly close. One cannot exist without the other; they progress hand in hand. We cannot have adequate cohesion or coordination without loyalty and we cannot have effective loyalty without *esprit de corps.*

Good tradition is a great aid to *esprit* and is too much neglected in the navy; which should profit by the superior example of the marines in this respect. Men and officers should be made more familiar with the notable deeds of their predecessors in the navy, and in their own ships, or ships of the same name.

Competition offers one of the most useful means of stimulating pronounced pride and *esprit de corps.* Good leaders make it their habit to introduce the element of competition whenever practicable; between gun crews, boat crews, turret crews, divisions, watches, ships, or any other units which organization or circumstances shape into the semblance of a "team." Competition is all the more effective when successful efforts result; but even when a unit is frequently beaten its benefits will not be lost if officers take pains to point out evidences of improvement and to give encouragement for better efforts in the future.

When recruits are being handled, either in competitions or in ordinary work, the repeated suggestion that they are making constant progress has an excellent effect in creating *esprit* and in promoting the desired progress. Necessarily some criticism cannot be avoided with inefficient men, and it is a mistake to fail in frankness with them; but the practice of offering them nothing but criticism, more especially when couched in such tone or language as to offend their self-respect, individually or collectively, is ruinous to *esprit*, and is a certain indication that the officer so doing is not a leader. It is essential that a *habit* of pride and confidence be created; and this can be done only by repeated praise and encouragement.

An organization permeated with a firm belief in its own abilities is stimulated to undertake cheerfully much more difficult and daring tasks and to exert greater efforts to accomplish them, than if such confidence was lacking. Obviously, then, *esprit* is an element of great military value. It is important for leaders to understand that *esprit* is an abstract conviction of excellence, rather than the concrete excellence, and has a strong coloring of vanity in it. Men must be made to believe in their organizations' efficiency; probably to a greater degree, but certainly no less, than is justified by the facts.

Esprit can also serve many commonplace uses. It is said that at one period the higher command of the American Expeditionary Forces in France were greatly concerned over the serious congestion of the roads due to disregard of the traffic regulations. The ordinary road signs appeared to have no effect and the only solution seemed to be to increase greatly the traffic police force, at the expense of the trenches. A free use of the sign "Play the game!" posted near the traffic signs, proved an effective solution of the difficulty. The success of this simple appeal was due to the high *esprit* and loyalty of the American Expeditionary Forces.

Another example of utilizing *esprit*, while at the same time stimulating it, is given by the following quotation from a sign posted conspicuously near the gangway of a destroyer tender: "Yes, you can have it. If we haven't got it we'll get it; if we can't get it we'll make it. What is it?"

To a marked degree *esprit de corps* is a measure of the spirit of the officers. None but they can create it; only they can easily destroy it. It is no unimportant part of the duty of officers to build

up their organization spirit by studied suggestion at every opportunity, and by unremittingly scrupulous example.

The inspiration resulting from *esprit* has an important bearing on all forms of efficiency, and is cumulative in its effects. *Esprit* promotes special endeavor and therefore high efficiency. Successful achievement in its turn creates pride in, respect for and loyalty to one's organization, and hence still higher *esprit*.

(d) *Patriotism.*—Considering the oath taken by all officers on accepting their commissions, there can be no question but that officers who refrain from inculcating high patriotism in their subordinates commit a grave breach of faith and moral duty. This is obvious; but what is not so clear is that such neglect also denotes inefficient Leadership; in that the important source of inspiration to be found in loyalty to a high cause is not utilized.

Loyalty to a cause is the highest and most effective form of emotional inspiration. It will spur men on to undertake more difficult tasks, to exert greater efforts, to endure greater suffering, and to make greater sacrifices than any other incentive. The higher the cause, the more idealism it embodies, the greater will be the incitement. Excepting religion, there is contained in patriotism the highest and most idealistic cause that can animate man. Past history abounds in examples of the extraordinary inspiration due to patriotism. The future will offer an even greater impulse; since recent events have demonstrated that nationalism must survive if anarchy is to be avoided, and the greatest good to the greatest number is to be ensured. Such a cause is capable of inspiring the highest loyalty.

Even if neglectful of his moral duty actively to promote and foster patriotism among subordinates, an officer who is a good leader will not fail to utilize patriotism as an instrument of leadership. An appeal to patriotism, where it can be used appropriately, will rarely fail to bring spontaneous response; once loyalty to the country, its institutions, and its ideals has been firmly established in men's hearts.

The American officer is prone to be diffident before his men about so sentimental a thing as patriotism, and to take it for granted that their patriotism is sufficient for the practical needs of the navy and Leadership. Considering the youth of our men, their heterogeneous racial character, and the great amount of Bolsheviki and other pernicious propaganda that has been dis-

seminated recently, it appears to be necessary for officers to undertake seriously the inculcation of patriotism.

Loyalty to any cause presupposes inner conviction of its justice and efficacy, and firm belief in the ideals for which it stands. Our men must be made to understand that the sane development of American institutions is the hope of humanity, and that such development is not possible unless stability and security are afforded the country by an efficient army and navy; which are under a solemn obligation, at all costs, to safeguard and further the country's interests at home and abroad whenever called upon to do so.

A valuable means of promoting patriotism is offered by inspiring tradition, in which American naval, military, and political history is rich. Few of our men are sufficiently familiar with this history to cause a pronounced feeling of patriotism towards the country. They should be thoroughly acquainted with the inspiring facts; and if the best results are to be obtained these should be brought to their attention repeatedly, because repetition is one of the strongest factors in creating a habit of thought.

Above all officers themselves must set an example of fine patriotism; scrupulously respecting the flag, and taking every occasion, by word and deed, to stand for America.

Patriotism, together with Interest, Self-respect and *Esprit de Corps* are four principal agencies through which men receive the inspiration needed to meet adequately the unusual exigencies of military life. An equally important element of inspiration is the example of the leader, but since this factor is very potent in all other aspects of Leadership it assumes the importance of a cardinal principle.

PRINCIPLE IV. THE LEADER'S EXAMPLE AND CHARACTER ARE THE MOST POTENT ELEMENTS IN LEADERSHIP

In exercising Control, in creating Psychological Harmony, and in inducing a needful measure of Emotional Inspiration, the value of the example of the leader can hardly be overestimated. This is largely due to the fact that his position renders him so conspicuous that every act constitutes a suggestion to others; and the influence of repeated suggestion upon crowds is very great.

The leader should personify the principles for which he stands; the captain or executive who lies abed until noon cannot expect

the ship to be cleaned in the morning watch. If officers are slack their subordinates are sure to follow suit; if they practice what they preach, the struggle to make subordinates live up to the same principles is furthered *tremendously*.

In addition to the example of conduct, bearing and appearance which it is so necessary to set, one who aspires to be a leader must possess certain attributes of character; developed to a much higher degree than is required for proficiency in lower ratings. Before proceeding to a consideration of these character attributes, it is well to reflect that character development is a slow and tedious process requiring persistent effort. The earlier it is begun the greater will be the ultimate development.

The subject of military character is too broad and complex to be treated fully within the scope of this paper. All that can be attempted here is to furnish an outline upon which a reflective officer may formulate an adequate conception of the attributes most needful of development in his own particular case.

The essential qualities of character required by leaders segregate themselves naturally into three principal classes.

1. Basic attributes of individual efficiency.
2. Attributes pertaining to cooperation.
3. Combative qualities needed to cope with an enemy.

Let us consider these in sequence.

1. *Basic Attributes of Individual Efficiency.*—If the respect and confidence of subordinates are to be commanded, a mind which is to think for and direct them should be an efficient mind; and this means developed *mental capacity* in many respects. The decision which precedes every order should be a sound decision; it should have a background of good knowledge and memory; and should be based on accurate observation and reasoning processes, both of which presuppose well developed powers of application and concentration. Very often decisions must be made quickly; hence a capacity for quick thinking is exceedingly useful to officers. Many circumstances require good imagination if due foresight and resourcefulness are to be exercised; imagination is the great creative agent and needs to be highly developed in officers. A correct decision will frequently need the quality of understanding, which has its origin in judgment and a sense of proportion and reality. Finally the officer must possess a strong will, so that he will surely order done what his mind tells him is the correct

decision, and will adhere to such decision in the face of subsequent obstacles.

The foregoing qualities of mental capacity should be combined with high *ideals.* "Honor, virtue, patriotism, and subordination" are prescribed by custom and regulations; to which should be added high ideals of loyalty, justice and duty. An intellectual rogue is as undesirable in a military organization as a stupid saint. An officer must embody the reverse combination if his individual efficiency is to meet the requirements of his position.

2. *Attributes Bearing on Cooperation.*—It is not enough that each officer or man shall possess only those attributes which render him individually proficient. In armies and navies one of the most prominent and governing conditions is that great numbers of men are thrown into close association, and that their efforts require to be harmonized and coordinated if success is to be attained. Minor friction between personalities may readily prevent due cooperation, and reduce the capacity for useful collective effort to a dangerous minimum.

First let us consider a group of cooperation qualities which may be generally classified as *Social Attributes.* The fundamental basis of harmonious association with others is *Charity;* which is manifested by unselfishness, sympathy, consideration, and tolerance. Besides charity the quality of *Sociability* is of great use in promoting harmonious association. Sociability includes civility and a sense of obligation to the community; it is promoted further by amiability and volubility, and to a marked degree by sprightliness, cheerfulness, and humor. In addition to Charity and Sociability human experience demonstrates that a degree of *Polish* is essential to the permanence of harmonious association. One cannot be too unconventional without giving offence to some who may misunderstand his motives and intentions. Good manners are a much safer and more rational rule of intercourse, since they have a universally accepted meaning. Polish also presupposes sufficient *savoir faire* to give a degree of assurance and tact without which sociability is marred greatly. The foregoing *Social Attributes* embodied in Charity, Sociability and Polish are indispensable to harmonious intercourse and cooperation.

Another class of attributes bearing on cooperation may be grouped under the heading *Personality.* Foremost in this class is personal magnetism, which is probably less susceptible of culti-

vation than any other quality of military character. Yet its development is so important as to call for special efforts. Poise and prestige are also needed to round out a good military personality, and their acquisition will also further the development of personal charm and magnetism. Poise and prestige go a long way towards creating in the minds of subordinates a belief in the leader's fitness to command them.

The third group of qualities needful in cooperation may be called *Expressive Attributes.* Obviously a leader must express to his subordinates clearly and effectively his ideas and orders if his men are to interpret them accurately, intelligently, and coordinately. A leader should be at ease when talking to a crowd, and be able to express himself with facility, either orally or in writing. Otherwise it will be impossible to get into other heads what is inside his own head, and coordination necessarily will be hampered.

Coordination is one of the cardinal factors of efficiency in every field of naval and military activity. The three groups of character qualities considered above, Social attributes, Personality, and the Expressive attributes, all have a vital influence upon a leader's ability to get cooperation among his subordinates.

It is necessary to consider, finally, the

3. *Combative Qualities Needed to Cope with an Enemy.*—Hostile operations require first of all that leaders be pugnacious.

Pugnacity implies a degree of arrogance towards an enemy. It includes courage; which normally is not so much a question of character as it is a product of conditions—feelings of confidence in strength and efficiency, high morale, etc. Pugnacity presupposes great determination; together with self-reliance and decision. It includes abundant activity, as well as boldness, dash and ardor.

The great balance wheel to pugnacity is *Steadiness.* Coolness and clear-mindedness under tension are especially desirable in one who must make the responsibile decisions. To carry plans through in the face of inevitable discouragements there are required hopeful buoyancy and much patience; besides highly developed endurance—both physical vigor and mental persistence. All these give steadiness.

Pugnacity with steadiness combine the principal combative characteristics, essential to cope with an enemy.

This completes the necessarily brief outline of the qualities most desirable in the military character.

Let us sum up the elements of Leadership. The basic principle is:

I. *A leader must exercise control over his subordinates.*

Control requires first of all, *discipline—i. e.,* instinctive obedience—and second, mechanical *drill.*

These agencies facilitate control not only in ordinary circumstances but also under the adverse influences presented by emergencies; and are established primarily through the medium of habit. A third factor in control is the proficiency of the leader in utilizing practically the power of *Suggestion.*

It is necessary that a leader shall establish supremacy over his subordinates through the above means; yet equally necessary that their inner hostility be not incurred. A paradox is avoided through the second principle, namely,

II. *Psychological harmony within an organization is indispensable to its general efficiency.*

Such harmony is obtained primarily through (a) a general belief in the prevalence of *justice;* (b) *understanding* on the part of subordinates of the need for the troublesome requirements of naval life and current work; (c) a spirit of *comradeship,* avoiding undue familiarity, between all ranks, and (d) adequate provision for interesting *recreation.*

The principle of psychological harmony is allied closely to that of control. They afford each other mutual support, and together furnish a good foundation for Leadership. Yet a third element is necessary, to avoid apathy and to supply an impulse for special effort.

III. *Some degree of emotional inspiration is essential to the highest efficiency.*

The most valuable agencies at the disposal of leaders, to give needful inspiration, are (a) *interest,* which may furnish a strong incentive under all circumstances; (b) *self-respect,* which is at the root of all the higher feelings; (c) *esprit de corps* (collective self-respect), which supplies constant inspiration for special effort and achievement by an organization; and (d) *patriotism,* a cause to which all can give the highest loyalty.

A capable leader will develop and make use of all these inspiring aids to the highest efficiency of his subordinates, and will utilize

also to the same end the influence of example. The importance of the latter is so great in its bearing upon all three of the preceding principles as to constitute a fourth cardinal principle of Leadership.

IV. *The leader's example and character are the most potent elements in Leadership.*

The force of the leader's *example* results from his being so conspicuous that his bearing and actions become constant suggestions for imitation by those under him. The example set necessarily depends to a great degree upon the leader's *character.* Military Character has three primary subdivisions: (1) Attributes of *individual efficiency,* whose principal components are ideals and mental capacity; (2) qualities bearing on *cooperation,* which comprise social attributes, personality, and expressive ability; and (3) the *combative* attributes, which are a compound mainly of pugnacity and steadiness.

A thorough understanding of the foregoing principles, together with facility in their practical application, is required of any officer before he can fulfil his primary rôle of a leader.

[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

STEEL TOWER CONSTRUCTION AT THE WORLD'S GREATEST RADIO STATION

By D. GRAHAM COPELAND,

Formerly Lieut. Commander Corps of Civil Engineers, U. S. Navy, Officer-in-Charge of Erection

HISTORICAL

When, during the latter part of 1917, it became apparent that existing cable and radio systems operating between the Allied countries and America, although working at a speed hitherto unprecedented in any commercial service, were rapidly becoming clogged and that constant communication between Washington and Paris could no longer be guaranteed, General Pershing requested, as a war measure, that immediate steps be taken to furnish him with means of assured communication. Inasmuch as radio matters in the United States, during the war, were handled exclusively by the navy, the War Department referred the matter to the Secretary of the Navy, who, in order to communicate with the navy's widely separated ships and to make communication with the American Expeditionary Force in France absolutely independent of the cables and beyond the possibility of interference from other radio systems, authorized the construction of the most powerful radio station in the world. This station, now known as the Lafayette Radio Station, is located at the village of Croix d'Hins, in the Department of Gironde, France, about 14 miles southwest of Bordeaux.

Arrangements were concluded early in 1918 whereby all structural steel, radio machinery, equipment, rolling stock and material for camp construction was procured in the United States, while the French Government proceeded with the preliminary work of

grading and construction of foundations. The extremely bad weather conditions prevailing in southwestern France prevented completion of the construction camp until the middle of July, 1918, and shortage of shipping facilities so greatly retarded shipment of tower material that tower erection was not commenced until October 1, 1918. As the signing of the armistice and the cessation of hostilities rendered the military necessity for the station inoperative and eliminated the original motive for its construction, all construction work was discontinued early in December, 1918. The French War Department, after some consideration, expressed its desire to have the work continued as an after-war project, but being unable to procure French labor sufficiently skilled in such work to ensure speedy and economical completion, requested the United States Navy Department to complete the station for the French Government. With this request the American Government complied and, on May 4, 1919, work was recommenced with date of completion of towers fixed as January 14, 1920. All work, with the exception of painting, which was delayed on account of rain, was completed on December 1, 1919, 44 days ahead of contract time.

GENERAL DESCRIPTION

The installation consists of eight 26-panel steel towers, 1312 feet 4 inches on centers, on reinforced concrete foundations, the tops of which are about 12 feet above the surface of the ground. The towers are triangular in plan, 820 feet high, 220 feet center to center of columns at bases, 105 feet center to center of columns 215 feet above bases, and 9 feet 8½ inches center to center of columns at tops, and are topped by a mast 18 feet high. The 20 upper panels are supported on a "portal," 215 feet high. The weight of each tower is estimated at 560 tons. The towers are set in two rows of four each, the centers of the towers being at the corner of 400-meter squares. The station will be able to transmit 72,000 words per day and will employ 500 k. w. on the antennæ. It will be more than five times as powerful as the Eiffel Tower Station, three and a half times as powerful as the Lyons Station and not less than twice as powerful as the strongest exist-

ing American, German and English stations. It will be possible, in fact, to radio to any corner of the globe, day or night—a feat not thus far accomplished.

The site is level and the soil sandy. In the rainy season, which extends from November 15 to May 15, the ground is saturated with water which frequently stands on the surface. During this season rain and high winds are practically continuous, so as to preclude any but shop work. In the summer conditions are ideal for tower erection, neither the weather being too hot nor winds too high to interfere with 12 hours' work daily. Ground water during this season falls to about three feet below the surface. On account of the sandy soil, which cuts up badly in summer and becomes soft and muddy in wet weather, it is impossible to operate motor trucks over the ground, and, accordingly, the handling of all structural steel and heavy material necessitated the installation of approximately five miles of standard gauge railroad track and the use of one saddle-back locomotive and two locomotive cranes.

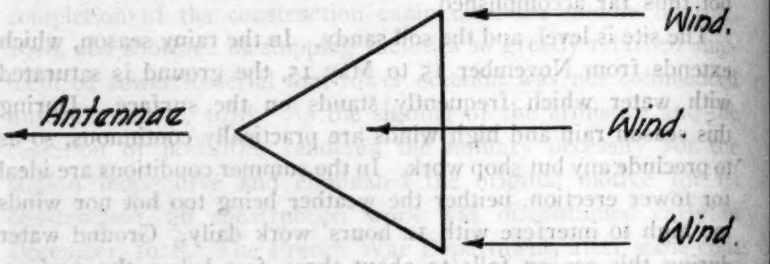
TOWER DESIGN

The towers were designed for the following stresses:

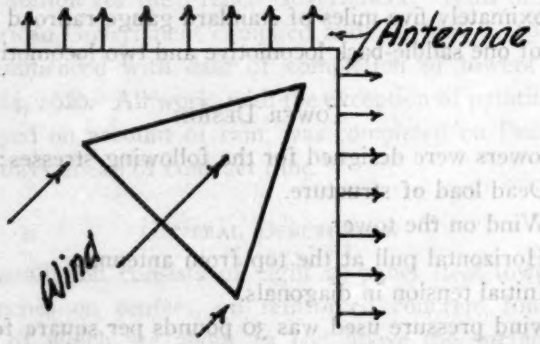
(a) Dead load of structure.
(b) Wind on the tower.
(c) Horizontal pull at the top from antennæ.
(d) Initial tension in diagonals.

The wind pressure used was 30 pounds per square foot. This is equivalent to a wind velocity of 87 m. p. h. by the formula $P=0.004\ V^2$, where P=pressure in pounds per square foot and V=velocity in m. p. h. The wind area was taken as 1½ times the exposed area of one face of the tower—this on the assumption that the members on the leeward side, being somewhat protected, get one-half as much as the members on the windward side. The horizontal pull at the top of the tower was 22,000 pounds, which represents the resultant pull due to tension in the antennæ and the stress caused by the wind blowing on the wires. The initial tension (stress due to adjustment) in the diagonals was taken as 10,000 pounds and was considered only in designing the diagonals and struts.

In designing the columns, the wind and antennæ pull was considered as tending to overturn the tower over on leg thus:



In other words, the overturning moment due to wind and antennæ pull is resisted entirely by the compression in one leg of the tower. This condition was obtained with the antennæ wires arranged according to the original plans as follows:



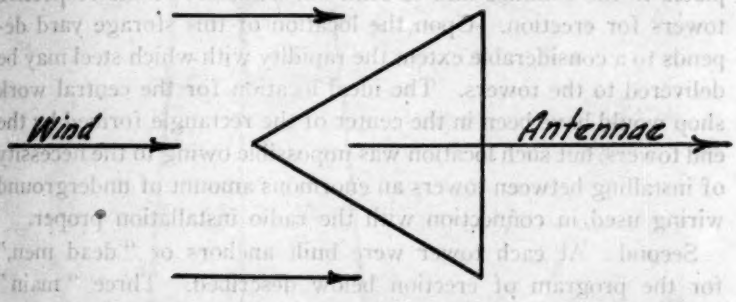
The arrangements of towers and antennæ wires was slightly changed before construction and, owing to the changes made, the members of the tower will not be subjected to as high stresses, but in the end towers, and in the intermediate towers when one set of wires is down, the condition will closely approximate that for which the towers were designed, and, accordingly, the design as originally made was not changed.

The unit stress allowed in designing columns was obtained by the formula $p = 18000 - 70\frac{l}{r}$, where l = unsupported length of column in inches and r = least radius of gyration. The maximum allowable value of $\frac{l}{r}$ was taken as 120. For example: the stress

in column KL is 553,800 pounds, the unsupported length is 470 inches and the least radius of gyration 5.41 inches. The $\frac{l}{r} = 87$ and unit stress equals 11,910 pounds. The area of section required equals $\frac{553800}{11910} = 46.5$ square inches and the area of section used is:

2 channels	15″	at	50 pounds	=	29.42 square inches
1 cover plate	16″	x	5/8″	=	10.00 square inches
2 side plates	12″	x	3/8″	=	9.00 square inches
			Total area		48.42 square inches

The unit stress used in designing the struts was obtained by the same formula as was used for the column, but the maximum



value allowed for $\frac{l}{r}$ was 150. These members, being in compression, were designed the same as the column sections. In this case, however, the area of the sections was determined by the $\frac{l}{r}$, for, with a section which gave the maximum value of 150 for $\frac{l}{r}$, the area was much greater than that required to take the stress in the member.

The diagonals take tension and were designed for a unit stress of 16,000 pounds. The base girders were designed to transmit the maximum stress from the columns into the foundations with the same conditions for which the columns were designed as stated above. The anchor bolts were designed to take the total uplift on the tower legs. The maximum uplift occurs with the wind and antennæ pull taken in the position shown above, and tending to overturn the tower about two legs. The uplift then equals the reaction thus produced at the windward base less the

weight of one-third of the tower. The amount of uplift in this case was 226,600 pounds and the area of anchor bolts required is $\frac{226,600}{16,000} = 14.1$ square inches. Two 3-inch diameter anchor bolts were used, giving a total area of 14.13 square inches.

ERECTION METHODS

The general scheme for erecting the towers was as follows:

First: All structural steel was delivered from freight cars to a central storage yard where it was sorted, carefully checked and stored. Then the practice was to assemble and rivet the column plates to the columns and to send out members to the respective towers for erection. Upon the location of this storage yard depends to a considerable extent the rapidity with which steel may be delivered to the towers. The ideal location for the central work shop would have been in the center of the rectangle formed by the end towers, but such location was impossible owing to the necessity of installing between towers an enormous amount of underground wiring used in connection with the radio installation proper.

Second: At each tower were built anchors or "dead men," for the program of erection below described. Three "main" dead men and six "wind" dead men were required for each tower. The "main" dead men restrained the legs from overturning until the structure was self-supporting and the "wind" dead men resisted transverse wind stresses.

Third: An "erection tower" was built on special concrete foundations provided for the purpose, this erection tower consisting of panels *J* to *P* of the main tower (see Fig. 1). The first two panels of these towers (roughly 81 feet high) were erected as a whole with 60-foot boom Brownhoist crane operating from a special spur track, while, for the remaining four panels, an 82-foot steel gin pole was used. This gin pole was supported in a bowl casting suspended by wire cable pendants attached to the portion of the tower already erected.

Fourth: After the "erection tower" was erected, three 120-foot steel booms were mounted on it for erection of the portal steel. These were stepped at panel point *N*, the supporting bracket being reinforced by a wooden strut. At panel point *N*,

wooden outriggers were built for attaching the swing lines, and, at panel point *P*, wooden members were provided for bracing the steel brackets to which the topping lift lines were attached.

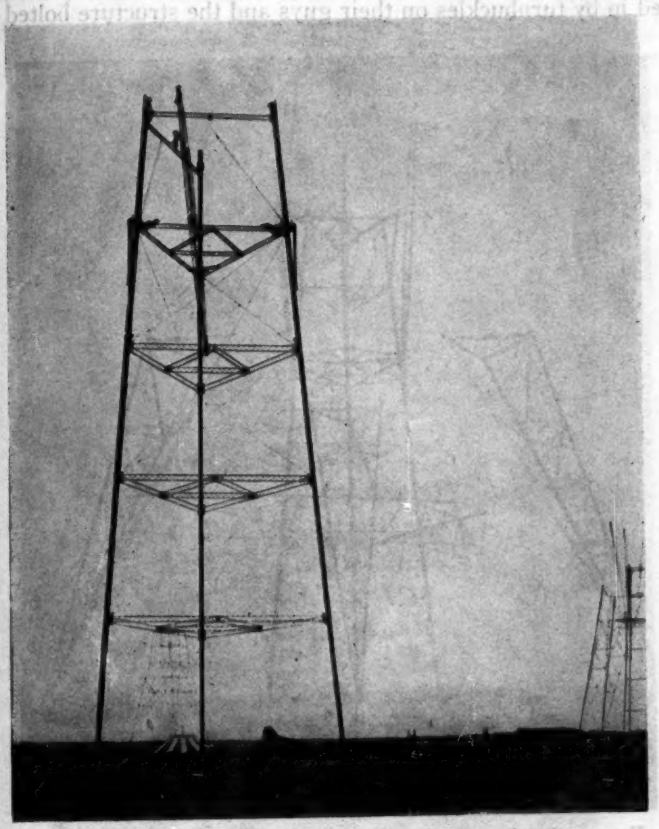


FIG. 1.—Erecting tower, consisting of panels *J* to *P* of main tower, used in erecting portal. Tower at right shows booms and rig used.

Fifth: After the booms were up and rigged and their respective hoists ready for operation, the portal steel was erected. The first guy was attached at panel point *B* and, when the leg had been erected to panel point *D*, a second guy was attached leading to the same dead man. As soon as the second guy was secure and tightened up, the first guy at panel point *B* was taken down.

Sixth: The *D* trusses and struts were riveted on the ground and hoisted in place as a whole. For this purpose all three hoists were used—the total lift amounting to 23 tons. As soon as the *D* trusses were raised to their proper elevation, the three legs were eased in by turnbuckles on their guys and the structure bolted up.

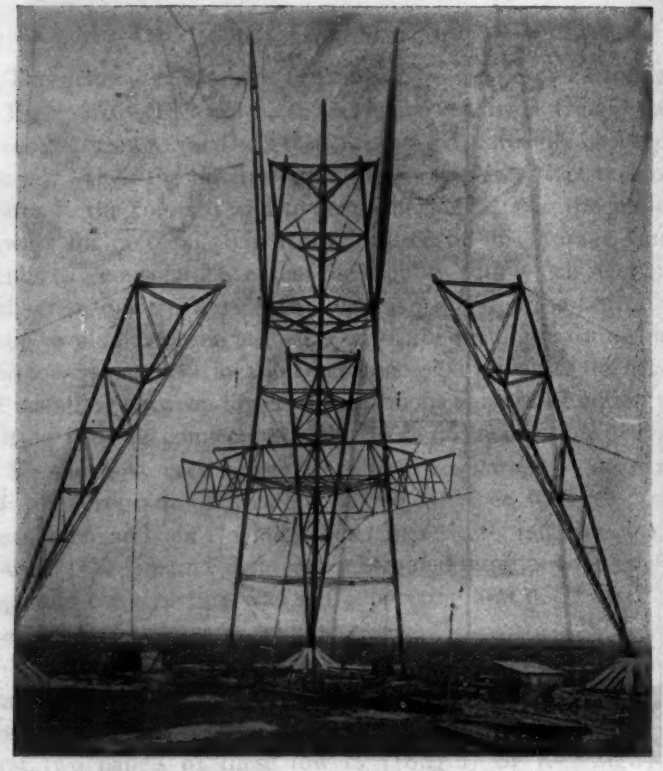


FIG. 2.—Placing D trusses at a single lift. Total weight 23 tons, span 101 feet. Note guys for main columns.

Seventh: The portal erection was then proceeded with as far as panel point *F*, a supplemental guy being attached at *F*. The trusses at *F* were also erected as a whole. To prevent distortion of various members, it was found necessary to retain all guys in place until the portal had been riveted (see Fig. 2).

Eighth: The columns of panel *F* to *G* were placed using the erection tower booms, after which these booms and the erection

tower were dismantled and a 130-foot length gin pole was sent up for the erection of the tower as far as panel point *L* (see Fig. 3). To support the *G* struts, 93 feet long, at their midlength, a temporary wooden member of 12″ x 12″ Y. P. was employed.

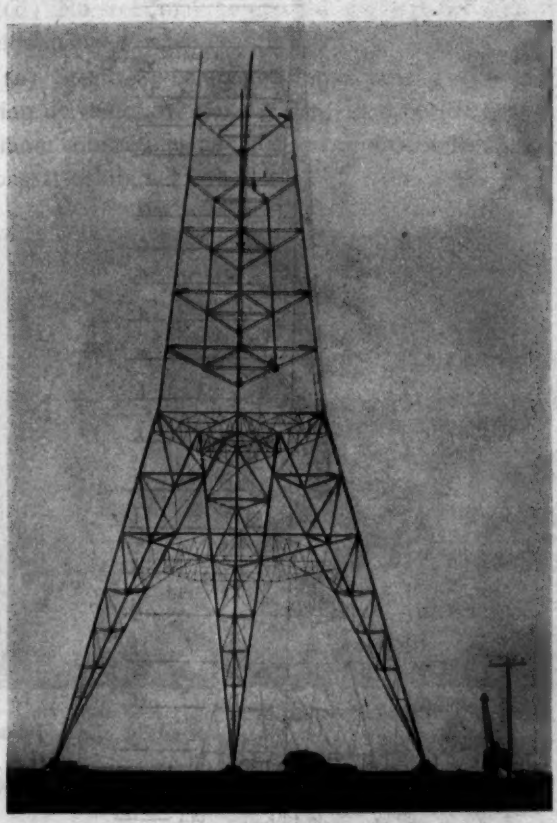


FIG. 3.—Erecting tower dismantled and being erected in place in main tower by 130-foot gin pole.

Ninth: At panel point *L*, a light gin pole 82 feet long was substituted for the heavy 130-foot pole and the erection completed by the suspended gin pole method. In order to reduce the interference of the interior struts with the gin pole when inclined the gin pole was supported as far as panel *J* from the middle of the horizontal struts instead of from the columns.

Tenth: As a safeguard against possible damage to the tower during erection through lack of sufficient bolts and rivets in connections, the following riveting schedule was rigidly adhered to:

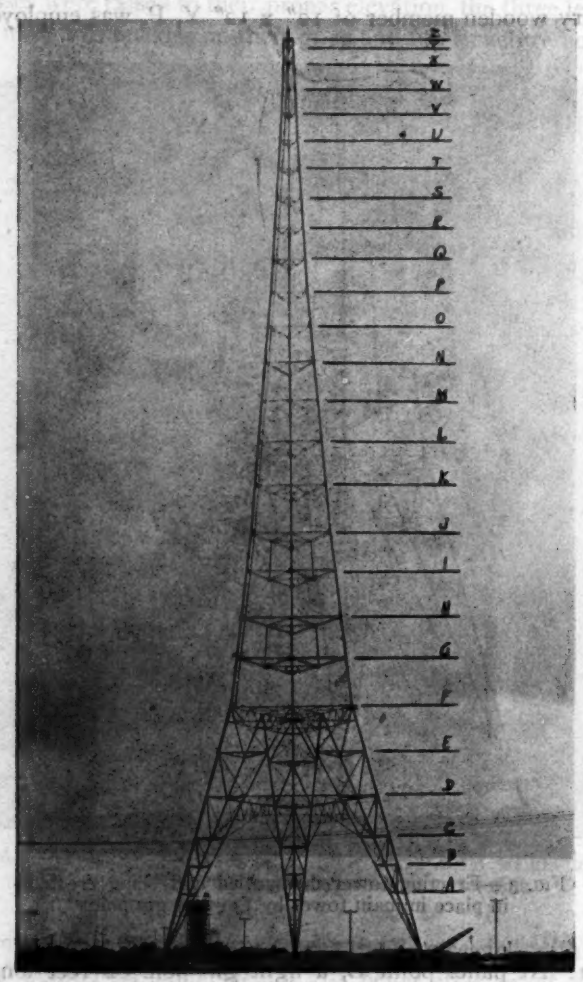


FIG. 4.—Showing completed tower and panel points.

(a) Steel may be erected to panel *H* without field rivets being driven below that panel.

(b) No steel may be erected above panel *H* until all rivets in panel *F* have been driven.

(c) Steel may be erected to panel *J* when all rivets in panel *F* have been driven and all panels below *F* have been bolted with not less than 60 per cent of the maximum number of bolts possible.

(d) No steel may be erected above panel *J* until all rivets below panel *F* have been driven.

(e) Steel may be erected above panel *J* without field rivets being driven above panel *F* provided 60 per cent of holes in column connections and 100 per cent of holes in strut connections at columns are bolted.

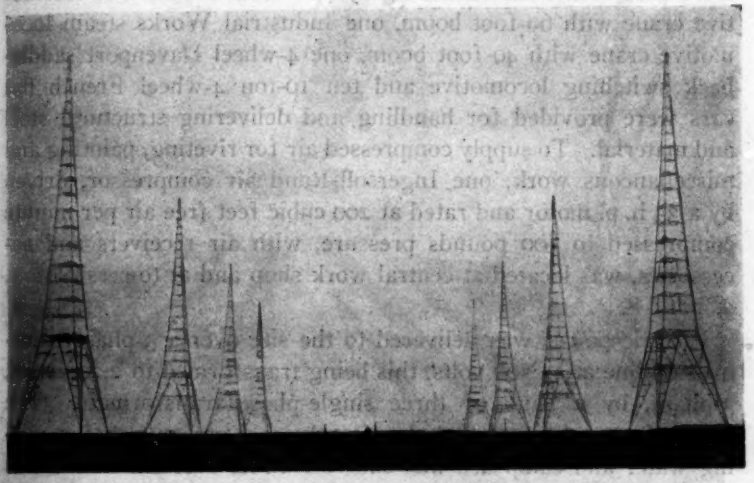


FIG. 5.—Completed project. Each tower is 840 feet high, including 12-foot foundation and 8-foot mast, and weighs approximately 570 tons.

Approximately 197,000 field rivets were driven, using air hammers.

Eleventh: Before erection all steel work was carefully examined as to condition of paint and places where the shop coat was not in good condition were well scraped, wire brushed, cleaned and given a fresh coat. Two coats of field paint were applied—one, Detroit Graphite Company's product No. 35 on the ground, and a second, the same company's product No. 59, after erection. Approximately 5000 gallons of paint were applied in the field by hand and paint spray.

EQUIPMENT

The power equipment at each tower (located in temporary sheds as shown in Fig. 5) consisted of:

2 double-drum hoists with 65 h. p. electric motors.
1 triple-drum electric hoist with 65 h. p. electric motors.

It was proposed at first to use steam hoists as a stand-by and six double-drum Lidgerwoods were furnished, but, owing to the reliability of the power supply and the excellent work of the electric hoists, the use of steam hoists was abandoned. Two 6-ton stiff-leg steel derricks, each with double-drum hoisting engine, were used in the central storage yard. One Brownhoist locomotive crane with 60-foot boom, one Industrial Works steam locomotive crane with 40-foot boom, one 4-wheel Davenport saddleback switching locomotive and ten 10-ton 4-wheel French flat cars were provided for handling and delivering structural steel and material. To supply compressed air for riveting, painting and miscellaneous work, one Ingersoll-Rand air compressor, driven by a 35 h. p. motor and rated at 200 cubic feet free air per minute compressed to 100 pounds pressure, with air receivers and accessories, was located at central work shop and at towers Nos. 1, 2, 4 and 8.

Electric power was delivered to the site over a 3-phase transmission line at 11,500 volts, this being transformed to 2,200 volts, 3-phase, by a bank of three single-phase transformers. The power for operating hoists, air compressors and pumps for cooling water and camp use was 220-volt direct current. To obtain this, two 500 k. w. General Electric motor generators (one solely for stand-by purposes) were furnished. These sets start as induction motors and run as synchronous motors. The average daily power demands when work was in full swing amounted to 120 k. w. As an index of the rate at which work was done, it is interesting to note the power demands during different periods of the day—7 a. m. to 9 a. m., 48 k. w.; 9 a. m. to noon, 180 k. w.; 1 p. m. to 2 p. m., 72 k. w.; 2 p. m. to 5 p. m., 168 k. w. The maximum demand for any one hour was 300 k. w.

FOUNDATIONS

As stated above, in order that all preliminary work might be completed prior to the arrival in France of structural steel and

erection equipment, the French Government was requested to put in the foundations for all towers. A plan of the proposed foundations was forwarded from America, but, for unknown reasons, the American design, consisting of the ordinary mass concrete type foundations on piling, was not followed by the French, who adopted a type probably never dreamed of in America, and which has been stated in French engineering circles to be a *véritable merveille d'art*. The designer of this "marvel of art" is M. Harel

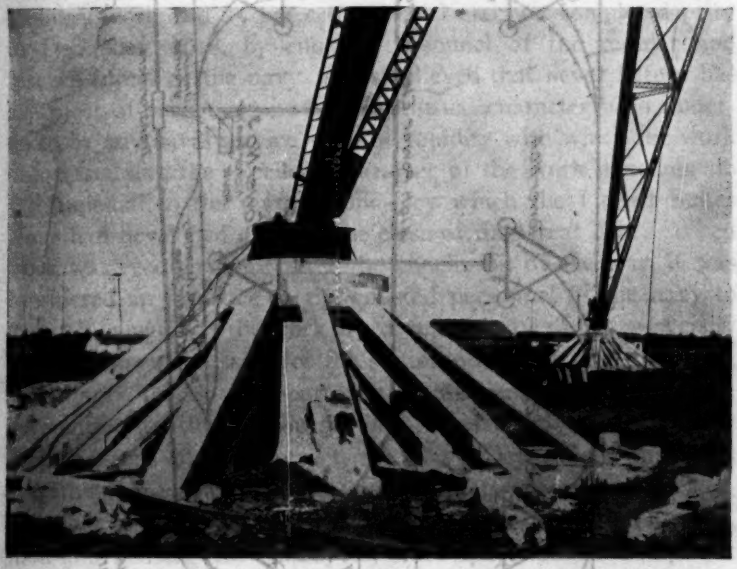
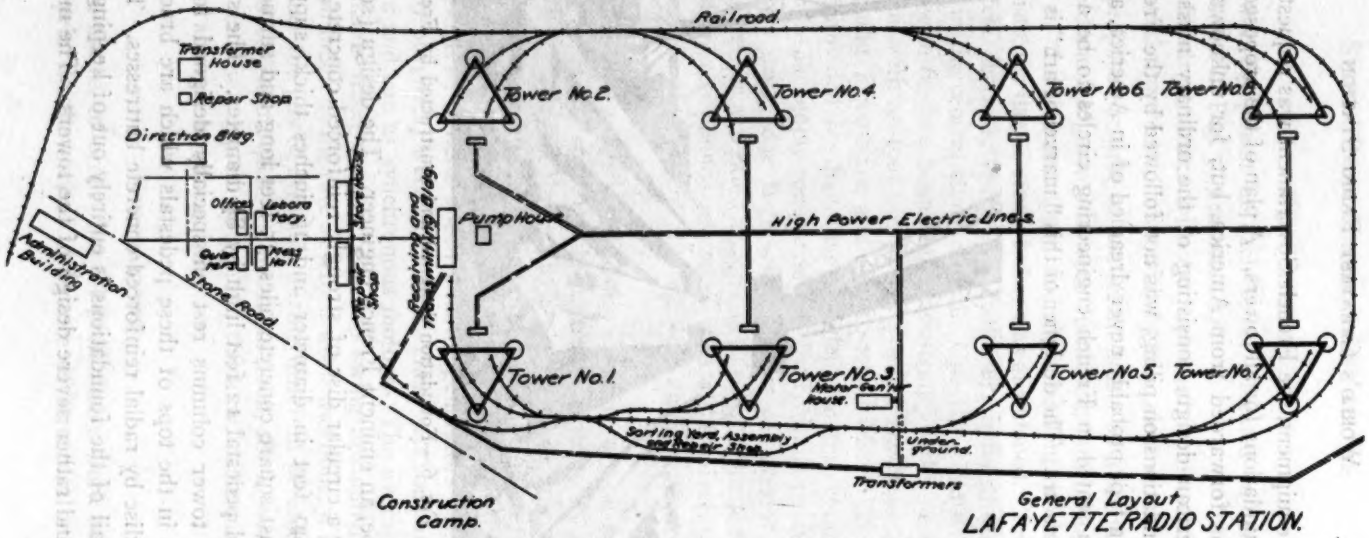


FIG. 6.—Foundation designed and constructed by French.

de la Noe, an eminent French engineer. The design (see Fig. 6) calls for a circular disc of strongly reinforced concrete, approximately 40 feet in diameter and 16 inches thick, supported by 28 precast square concrete piles, 35 feet long and surmounted by a central pedestal 12 feet high by 8½ diameter. The steel shoes for the tower columns rest on specially designed footings in recesses in the tops of these pedestals which are braced to the bottom disc by radial reinforced concrete buttresses. The elaborate detail of the foundations is entirely out of keeping with the simple and rather severe design of the towers. The mental atti-



General Layout
LAFAYETTE RADIO STATION.

tude on matters of foundation design of engineers of various nationalities is rather strikingly illustrated by the comments of several eminent engineers who have inspected the work. An American, "But think of the cost!"; an Englishman, "The severe, staunch appearance of your towers is ruined by the foundations"; a Frenchman, "*Véritable merveille d'art*"!

CAMP AND PERSONNEL NOTES

The actual camp construction work was undertaken, all preliminary work and 25 per cent of steel erection completed prior to December, 1918, by enlisted personnel of the regular and reserve forces of the navy. It is believed that never before has a project of such magnitude and unusual character been undertaken by any naval service, and the rapidity with which the work progressed and the excellent character of the work done remain a testimonial to the marked efficiency which the United States Navy had developed prior to the close of the Great War. When work was recommenced after the conclusion of the war, it was considered an injustice to the enlisted personnel of the navy to expect it to continue the work at the enlisted rate of pay, especially as the military necessity for the station no longer remained, and, accordingly, the Navy Department let the completion of the work by contract to the Pittsburgh-DesMoines Steel Company. By the conditions of its contract, the Navy Department furnished everything necessary for the work with the exception of labor. This included transportation of employees to and from France, food and housing for employees, office space and all equipment and material.

It is interesting to note the accommodations furnished the workmen. Owing to the isolated location of the station and, believing that contentment spells efficiency, every effort was made by the naval authorities to take care of the men properly. The results obtained may well serve as an example for others engaged in similar work in a foreign country. Space in navy standard portable barracks, which are light and airy, well ventilated and easily heated in winter, was provided at the rate of 500 cubic feet per man. A substantial iron cot with good springs, mattress, four sheets and two pillow cases was given each man. Foremen were assigned to separate barracks with double space. Superin-

tendents and office force were quartered in officers' barracks. Two medical officers and one dental officer were provided and furnished their services to all without charge. A dry canteen where navy standard shoes and clothing (uniforms excepted), candies, sweets, tobacco, soap and other necessary articles might be bought, was run by the government without profit. A branch post office where money orders might be purchased was established. Excellent messes for foremen and workmen were maintained and run by the government without cost to the employees. The food served was the navy standard ration somewhat altered to meet the requirements of steel workers. These messes were models of cleanliness and were up to date in every respect. They were run on the cafeteria system and all modern culinary apparatus was provided to ensure success. When it is realized that 400 men were served three times a day in less than 12 minutes per meal, it will be seen how thorough this detail was. There was scarcely ever a complaint received. The cost of the service to the government was extremely low, averaging about 90 cents per man per day.

Owing to the prevalence throughout France of skin diseases, which are spread chiefly by hand laundries where all kinds of clothing are washed in the same tub, or pool, it was found necessary to install a modern steam laundry to take care of the force's laundry. This was the only service for which the government charged, but charges were just sufficient to cover cost of operation and replacement. From the start the laundry was well patronized, and its use soon caused an abrupt drop in the number of admissions to the sick list.

To keep the men on the station and away from the hundreds of saloons, 10,000 licensed women in Bordeaux, and unknown thousands of unlicensed, a recreation hall was established. This had a seating capacity for about 600, and, through the courtesy of the Y. M. C. A., Red Cross and K. of C., it was possible to fit it up for theatricals and movies. Billiard tables, barber shop, library and reading rooms were also provided. Twice weekly performances were given by Y. M. C. A. entertainers and every other night movies. On Sunday, religious services, to which every race and creed was invited, were held. The value of this experiment is apparent to anyone who knows the tendency of men to commit excesses in a foreign country, where conditions are so

different from those existing at their homes. I am convinced that the almost total absence of "blue Mondays" on this work was due entirely to the wholesome amusement provided for the men in camp. The actual cost of this feature was less than $300, due of course, to practically everything being donated by the organizations above referred to. However, I feel sure that an expenditure of $10,000, had it been necessary, would have been wholly justified and would have paid big returns.

The design and general layout of this radio station was made under the Bureau of Steam Engineering, Rear Admiral R. S. Griffin, U. S. N., chief of bureau. The public works features, including the design and preparation of all plans for the towers, were carried out by the Bureau of Yards and Docks, Navy Department, Rear Admiral C. W. Parks (C. E. C.), U. S. N., chief of bureau.

The actual work at the site was begun under the administration of Lieut. Commander Geo. C. Sweet, U. S. N. (Retired), commanding officer, and under the personal supervision of Commander F. H. Cooke (C. E. C.), U. S. N., who completed the construction camp and about 25 per cent of the steel erection; and the work at the site was completed under the administration of Captain A. St. Clair Smith, U. S. N., commanding officer, under the personal supervision of Lieut. Commander D. Graham Copeland (C. E. C.), U. S. N., officer-in-charge, and Lieutenant A. C. Eberhard (C. E. C.), U. S. N., assistant. The construction work was handled for the Pittsburgh-Des Moines Steel Company of Pittsburgh, contractors under the Navy Department, by Mr. H. W. Smith, superintendent, and Mr. Loyd Ellis, assistant superintendent.

[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

OUR DIVIDED PERSONNEL

By Rear Admiral A. C. Dillingham, U. S. Navy

It is a mistake made by officers, who believe, that, with their retirement, their life's work is finished, because with many such officers, their experience, mature years and rank, their opinions on professional matters, are, more or less, respected, and if their influence is properly used, it might be of great value to the service.

My attention has been called to an article appearing in the New York *Times* of August 2, 1920,[1] entitled "Our Divided Navy—Questions of American Policy Brought to the Front by the Proposed Panama Maneuvers" and signed "Americus."

I believe that I recognize the writer of this article, as an officer of mature years, long experience, retired statutory on account of age, a student of naval history and strategy, who might possibly be called a pupil of Mahan's, one whose influence might be of great use to the navy, if properly applied.

The derisive style of the author and his indulgence in personalities, displays an effort to influence the public to accept his views of the condition of the navy to-day, as failing to meet the basic principle of organization, and a failure in administration to appreciate the mission of the navy.

I declare that the author violates the basic principle of administration, which is co-operation, that his method is obstructive and dangerous, and that he ignores and violates the best traditions of the navy. The result of the late investigation concerning matters in the navy, has apparently brought a division of sentiment amongst the officers, which is entirely wrong and damaging, and which, as a matter of fact, has no reason to exist, because, though the testimony of officers presented at the investigation may have

[1] This article appears in the Professional Notes, page 2018.

differed as to opinion, the fact and principle remained the same with all who testified. Without going into this investigation, I believe it can be said that every officer testifying as to his command, intended to declare the efficiency of that command, "as far as the circumstances would permit," and I believe that every officer knows, and believes, that our unpreparedness for war was, and is, absolutely up to the creative body, Congress. We must not forget that in our country there is no co-ordination of the makers or framers of policy, and the force that is to back that policy, and it is a fact that most of our troubles come from serving in a military profession in a non-military country and many from irresponsible legislation. But we cannot help this; our business in the premises (and this is the acme of efficiency) is to get results with what we have.

There is nothing new in what "Americus" says in his article; it is well known by all officers and, in the division of operations, that the basic principle of all organizations is simplicity and that it must be based upon logical principles and that, if the organization of the fleet is not ideal, or consistent with the requirements of battle, we will not get the best results from operations, though the administration be ideal. I believe it can be truthfully said that the administration of the fleet was never more nearly ideal, from a military viewpoint, than it is to-day, not that it meets entirely the requirements of ideal military administration, but it is more nearly that, than it ever was before.

Our navy is essentially a two-ocean navy, so that our extreme mission requires an organization capable of carrying on successfully war in the Atlantic, and in the Pacific, at the same time.

Under such circumstances the initial organization, which would represent our extreme mission, would divide the fleet into two parts, known as the Atlantic and Pacific fleets. The organization of these fleets is identical and permanent, so that it would make no difference in adding or subtracting units from one or the other.

We deviate from or leave the initial organization to meet the demands of the political aspects of the world, so that we can say that the composition of the fleet will depend upon the political aspect of the world, and this is in the hands of the Chief of Operations.

We are obliged, with our institutions, and with what the creative body, Congress, gives to us, to deal with expediences, and

that is exactly what the Chief of Operations is doing to-day. He is endeavoring to meet these expediences, and to, as far as possible meet the demands for a single fleet. I believe that officers will agree with me, and that Operations is of the opinion, that the same reason for a single command ashore exists for a single command afloat. If our extreme mission is to be so organized as to successfully carry on war in the Atlantic and Pacific at the same time "Americus" might possibly find in "proposed Panama Maneuvers" an effort on the part of Operations to test such an organization, or it might be that our lack of operating bases in the Pacific prevents mobilization of the entire force on that coast, or that economic conditions may require a division, nor must we forget that the mobility of our force is greatly increased with the Panama Canal in operation.

The present Chief of Operations is an officer of experience with a very level professional head, but, in his efforts he has not the co-operation of certain officers of the service, as is exhibited by "Americus"; he is obstructed and may be seriously obstructed by a public sentiment that "Americus" is endeavoring to create. I claim that this is not becoming a good officer and that it is violating the best traditions of the navy, which has always been loyalty to each other, with an *esprit de corps* which was admirable. The Chief of Operations is approachable; he is always accessible; he is ready to consider seriously professional advice or convictions, and the only proper way for an officer in the navy to better the service is to co-operate with the Chief of Operations, who is the military head of the navy. It was only a few days ago that I took the liberty of writing to the Chief of Operations a personal letter upon what I thought to be an important professional matter. I received, by return mail, a very full and considerate reply with assurance of his interest and his thanks for my suggestions. The same course is open to every officer in the navy and will receive the same attention.

I believe that the Chief of Operations is supported by a large majority of the officers in his efforts to put the navy on a solid foundation after its apparent slump since the World's War, but there are certain officers, "Americus" for instance, who do not co-operate with him, certain officers who by these anonymous letters and growling, display a destructive intention, that is lamentable.

We must have co-operation, for without it no administration will ever succeed, and though this Naval Institute gives to us an opportunity of presenting our professional views, I believe that it would be to the advantage of the service, if we could have once a year a convention of naval officers, where, as officers, and as man to man, open and above board, we could present our views and discuss them for the best interest of the service. This in no way could interfere or intrude on the prerogative of the War College, or any other institution that we might have.

Let us get back to our single aim—the good of the service; let us forget personalities, with our intense interest for the good of the service; let us demand that officers cease their efforts, especially in print, to pull down the military head of the navy by such articles as "Americus" sees fit to publish, and so follow the splendid traditions of our navy.

[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ADMIRAL NEARCHOS

By CAPTAIN C. O. WRIGHT (Ch. C.), U. S. Navy

Among all the great men associated with Alexander no one has left a reputation more noble and unsullied than Nearchos. The long and difficult voyage in unknown seas which he successfully accomplished ranks as one of the greatest achievements in the annals of navigation.

Nearchos the Cretan, as he was called, must have been known more as a soldier and administrator than sailor when placed in supreme command of the 2000 vessels and rafts, large and small, of Alexander's fleet, in which he made but the one voyage—down the Indian rivers and along the coasts to the head of the Persian Gulf—though he is spoken of as an "experienced navigator."

Son of Androtimus, Nearchos was born in Crete, but in early life was settled at Amphipolis in Macedonia near the Thracian boundary. He is said to have been educated with Alexander under Aristotle, along with such other noble youths as Theophrastus, Ptolemy, and Harpalos, and afterwards remained in high favor with King Philip, till, because of his adherence to the Prince Alexander, he, together with his companions, was banished from the kingdom. Soon after Alexander succeeded to the throne he was recalled, and when the conquest of Persia was begun he took an intimate part with his leader in the earlier conflicts, and was appointed to govern the important districts of Lycia and Pamphilia in Asia Minor for five years. He appears to have acquitted himself so well in this employment that he was called to rejoin Alexander in Persia where he was counted among the royal favorites and confidants.

"He was one of the most distinguished of the friends and officers of Alexander." It is recorded that he accompanied Alexander in the Bactrian expedition in command of a body of mercenaries, and was present at the brilliant capture of the rock

Aornos, having rejoined the king in B. C. 329. In the ensuing subjection of the eastern part of the Assakenians, we are told that Alexander "sent out Nearchos and Antiochus—commanders of the hypaspists, the former with the light-armed agrarians—to examine the nature of the localities, and to capture, if possible, some of the barbarians who might give information about the state of matters in the country, and particularly about the elephants, as he was very anxious to know where they were."

Nearchos was counted among the learned ones of his day, and it is known that he wrote a history of the king's wars as well as books on natural history. While in Asia Minor he made extensive collections of observations concerning the plants and animal life, the habits, customs, dress, etc., of the inhabitants, and of the climate and geography of the countries far to the eastward—the latter at a later day. These notes on India were carefully and industriously compiled, and it may be that they were inspired by the king in anticipation of his invasion of that country. Neither these works nor his elaborate log of his famous cruise have survived, but they have been largely preserved in extensive quotations by later Greek writers.

As part of his far-flung plans, after the signal victory over Poros, Alexander gave orders for the immediate construction and equipment of a great fleet at the Hydaspes (at the newly built city of Nikaia), probably with a profoundly complex purpose, viz., as refuge in case of necessity; to complete the circuit of his eastern conquests; as a vindication of his rulership; and to link India, if successfully conquered, to his empire by sea as by land. As to the first, his wisdom was strikingly vindicated at the Hypasis, which his worn and wearied army refused to cross or to proceed any further, after so hardly reaching this eastern boundary of the Panjab (September, 326 B. C.). In this new and critical situation the ever-resourceful king had but to retrace his course to the Hydaspes and the sumptuous camp and building fleet to restore the health and spirits of his hosts, and to turn what might have proven a very embarrassing retirement into a triumphant completion of conquest.

Here, at his new city of Nikaia, while the fleet was being assembled, built, and equipped, he established a vast encampment, and inaugurated elaborate games and celebrations of his victories, and made division of spoil and treasure. And, when his soldiers

were happy and loyal again, he wisely sent home the ill and decrepit all well laden with honors and spoil. Others he placed in the numerous strongholds and colonies he was constantly establishing for the maintenance of his wide boundaries.

As to the construction of the fleet at the place chosen, it appears to have come about from two features or facts: the craft with which the Indus had been bridged were brought across country in parts to be used again at the Hydaspes, and this enterprise and the various transportation needs of the expedition had undoubtedly brought together here already a great number of boats, rafts, etc.; and adjacent was a large area of fine timber fit for building the larger vessels, and, besides the desirability of having its construction under his own keen eye, and in full view of the camp which supplied much of the labor, it was located in a fine and friendly country well supplied with food and other desirable materials.

Ere long a sufficient number of boats were in readiness. As no mention is made of Nearchos as having taken part in the battle with King Poros nor in the subsequent march to the Hypasis, it would seem most probable that he had been engaged in the supervision of this project, assisted by King Omphis of Taxilia and Krateros.

Among the 2000 vessels assembled there were eighty 30-oared galleys—some with a bank and a half of oars—and from statements of Nearchos it is probable there were 800 armed boats or war vessels and transports. When ready for final equipment, 24 Macedonians, eight Greeks, and one Persian were appointed captains of trierarchs, and, as was the ancient custom, "assigned the expense and honor of fitting out these larger ships." As to the army, it was instructed to forage in the adjacent rich country for 30 days before the time for departure southward, and most of these supplies were to be carried by the fleet.

But who was to command such an expedition? Who was capable of inspiring the men with confidence; or persuading them, that in undertaking such a service they were not abandoned to destruction? "Such," says Nearchos, "was the perturbation of Alexander when he ordered me to attend him, and consulted me on the choice of a commander. 'One,' said he, 'excuses himself because he thinks the danger insuperable; others are unfit for the service from timidity; others think of nothing but how to get home; and many I cannot approve for a variety of other reasons.' Upon hearing this, I offered myself for the command, and promised the king that, under the protection of God, I would conduct the fleet safe into the Gulph of Persia,

if the sea were navigable, and the undertaking within the power of men to perform." Alexander hesitated, he loved Nearchos, and admired him the more for the promptitude of his offer. . . . . Nearchos persisted in his proposal, and entreated the acceptance of his services. At length the king consented, and named him admiral of the fleet. Arrian introduces this account after the fleet had reached Pattala; but as Nearchos commanded during the passage down the Indus, it is much more probable that the consultation took place before his first appointment.—VINCENT.

"Nearchos the Cretan was made admiral of the fleet and old Onesicritus or Onesicrates the pilot of the royal galley, both destined to win immortal fame by their accounts of the voyage they were beginning." As the admiral did not always follow the nautical advice of this sea-guide of the king's vessel, and as the latter has been detected in falsely describing himself as in command of the fleet, it may have transpired that some jealousy and disagreements cropped up between them during the long and trying cruise upon which they were entering.

Unfortunately, the admiral's journal or log of the voyage was subsequently lost—like almost everything else connected with Alexander's realm and reign—but, as mentioned, the substance has been preserved, principally in the writings of Arrian, so that we are able to reconstruct from the surviving fragments an intelligent and profoundly interesting sketch of his cruise.

Having refreshed and supplied the army, and equipped the fleet, Alexander, who ever retained supreme command of both when in touch with them, now placed some 8000 men on the fleet, together with the heavier impedimenta and treasure, as well as spare horses (on vessels specially built for them) and some of the great savage dogs which had been presented—150 of them, said to have been bred from tigresses—by King Sophytes. When all was in readiness, Alexander made the following disposition of the army:

He took in the ships along with himself all the hypaspists, and the archers, and the agrarians, and the corps of horse-guards. Krateros conducted a division of infantry and cavalry along the right bank of the Hydaspes, while Hephaistion on the opposite bank advanced in command of the largest and best division of the army, to which the elephants, now about 200 in number were attached. These generals were instructed to march with all possible speed to the palace of Sophytes—[probably to enable the admiral to replenish his stores, and it may have been also to arrange for control and exploitation of the extensive gold and silver mines in that vicinity; and another large body of troops was to follow them after three days. Most

probably Nearchos carried his own troops with him aboard, and utilized many of them to man his fleet—an early instance of the "Soldier and Sailor too"—in fact, a body of his force afloat is spoken of as *marines*.]

All now being ready, "after solemn offerings to the gods of river and sea, the great fleet at dawn of some day in October, 326 B. C., pushed out upon the current, and in stated order started down towards the sea," without chart or compass or experienced local pilots—at least, it may be said that none of the native pilots employed by Nearchos appears to have been familiar with the entire stream nor with the whole stretch of rivers to be traversed. As it was the flood season, the situation called for local knowledge of shores and streams continually—for the guidance of the marching troops and the drifting fleet. Nearchos could not go far ahead of the troops, as he carried not only the commanding king, but much also of their gear and supplies, and 8000 soldiers, and the resistance of some of the tribes encountered was strong and persistent till they were conquered, reconciled or destroyed.

The end of Alexander's conquests had been reached, and the return to peace and settled life had begun. Standing in the prow of the royal galley, he poured from a golden goblet libations to each of the rivers on which he was to sail; again he poured to Hercules, to Ammon, to each of the gods whom it was his wont to invoke; and then the trumpet rang out, the oars moved, and the strange argosy was on its way towards the unknown ocean.

All the long cruise on the rivers, until the sea voyage was begun, Alexander kept with Nearchos's fleet, voyaging in his royal galley—in fact, in command, as has been said, of both fleet and army, though the admiral carried out the king's orders and wishes, or executed them on the water, nor is there any indication of fault-finding by Alexander nor of clash of authority.

As to route and methods, the king seems to have determined to follow the course of the Persian explorers before him, descending the streams flowing most directly southwards to the ocean; but he had no thought of leaving a single enemy or possible local rival behind him, so that he must have set himself the strenuous task of the conquest of all the great tribes en route, and this he appears to have accomplished during the eight or nine months consumed in the river cruise.

Proceeding down the Hydaspes to its junction with the Akesines, and down that river to its junction with the Hesidrus, Nearchos had but a short 60 or 75 miles to make till he floated

out upon the wide brown bosom of the Indus which was now to be his highway to the mysterious sea.

At the junction of the Akesines another memorial "Alexandria" had been built; and on the way several tribes and large districts had been conquered. Of these the Mallians proved the most troublesome. It was in the taking of their capitol that Alexander came so near capture or death, and was so seriously wounded, and these events and his thrilling display of noble courage and military skill are all graphically related by Nearchos in his log, where he also records the intimate fact that some of the king's closest friends and companions (he himself, no doubt, among them) now went in a body to his galley, where he lay so sorely wounded and ill, and ventured, after some hesitancy, to remonstrate with him for having so recklessly exposed himself in this last affair, and urged that such should be the duty of the common soldier and not of the general, which grieved Alexander, though he embraced them later and generously commended them for this, another evidence they had given him and the gods of their loyalty. But there was present, Nearchos says, an old soldier who (he may have been a privileged character there) made bold to say aloud, "Deeds, Alexander, tell the man," and glibly quoted from Aeschylus the line, "Who does must suffer," which amused and pleased the suffering king greatly.

To allay the despair in the army and fleet caused by reports of his death, "it was necessary, as soon as he was able to be moved, to show him to them alive, on board a vessel which was floated down the current without the use of oars, to avoid all shock and noise."

Just previous to this campaign, Alexander had overrun the territory of the Sibi who claimed to be descendents of soldiers of Hercules who had been left behind there because of illness. But, after many days of hard fighting they were overcome and obliterated. Of one of their cities it is said, "the inhabitants, despairing of their safety, set fire to their houses, and cast themselves together with their wives and children, into the flames. The citadel of the town had escaped damage, and Alexander, accordingly, left a garrison behind in it. He was himself conveyed by boats around the fortress—three rivers there washed the base thereof."

Surprise and some disaster awaited the admiral at the junction of the Indus. The pilots, finding they were not strictly guarded,

absconded, and he sent out in search of others, but none were obtained, and the rest of the voyage had to be made without any pilots other than a few inexperienced natives of those parts who earnestly endeavored to guide the fleet though they possessed little or no knowledge of the course of the river, its currents, depth, shoals, tribes to be encountered, etc., or the distance to the sea.

Another disastrous event encountered here was the *bore* of the Indus. The streams met with a tremendous roar, and formed a deadly vortex.

The meeting of the rivers makes the water swell in great billows like the ocean, and the navigable way is compressed into a narrow channel by the extensive mud-banks kept continually shifting by the force of the confluent water. When the waves, therefore, in thick succession, dashed against the vessels, beating both on their prows and sides, the sailors were obliged to take in sail but partly from their own flurry, and partly from the force of the currents they were unable to execute their orders in time, and before the eyes of all, two of the large ships were engulphed in the stream. The smaller craft, however, though they were unmanageable, were driven on shore without sustaining injury. The ship which had the king himself on board was caught in the eddies of the greatest violence, and by their force was irresistibly driven athwart and whirled onward without answering the helm. He had already stripped off his clothes preparatory to throwing himself into the river, while his friends were already swimming about not far off ready to pick him up, but as it was evident that the danger was about equal whether he threw himself into the water or remained on board, the boatmen vied with each other in stretching to their oars, and made every effort possible to force the vessel through the raging surges. Suddenly the waves parted and the currents subsided sufficiently for the boat to be stranded on the shoal near by.

Alexander there erected as many altars as there were rivers, and, after sacrificing on them, prepared to march onward.

After reassembling, refitting, and rebilleting his ships, Nearchos declared all in readiness again, after a considerable delay, and the voyage on the Indus was begun, the two armies marching on either side as before, and meeting with frequent and serious warfare, subduing the adjacent country along the route. Nearchos relates the circumstances attending the capture of some of the philosophers who were known to have persuaded their kings and princes to resist Alexander and who were, therefore, held responsible for much of the bloodshed and loss that ensued. These sages, being adepts in the art of returning brief and pithy answers to hard questions, were put through their rôles by Alexander with a number of difficult questions in the presence of his friends and

sages, and then dismissed with appropriate presents. Onesicritus, the royal pilot, being a Cynic philosopher, was sent to the most renowned of the sages, who lived in seclusion, one of whom, Kalanos, he persuaded to visit Alexander, and who consented to continue with the king. It was this Kalanos who afterwards, when in failing health, so Nearchos relates, immolated himself on a pyre in the presence of the wondering camp in Susa.

The admiral found many surprises on the Indus, and the task of keeping in touch with the army, supplying its needs, besides the constant care of his vessels, to say nothing of the strenuous problems of navigation which arose continually, all combined to tax his utmost ability and strength, yet he appears to have borne up bravely and triumphantly to the end.

In a way, the voyage down the rivers was a kind of triumphal procession. "The size of the vessels, the conveyance of horses aboard, the number and splendor of the equipment attracted the natives to be spectators of the pomp. The sound of instruments, the clang of arms, the commands of the officers, the measured song of the modulators, the responses of the marines, the dashing of the oars, and these sounds frequently reverberated from overhanging shores"—altogether it was a magnificent experience, and one which must have aroused the pride and joy of those who shared in it. Arrian freely attributes the happy consummation of the enterprise to the prudence and judgment, as well as the courage, of the admiral.

Finally, after the lapse of so many crowded months, the mouth of the Indus was reached, at Patala, where Alexander ordered the construction of a ship-yard, harbor, and fortifications. And here another big surprise was encountered, for, proceeding then to explore the delta, "Alexander made his astonished acquaintance with the phenomenon of the tides; then, without returning on the sea, he contented himself with a three-day journey along the shore, in order to form an idea how a fleet was likely to fare in a coasting voyage." Presumably, he was accompanied on this three-day trip of level-headed investigation by his admiral and pilot. From this point they were to proceed without him.

It seems that the fleet had been brought down the western arm of the Indus, and that it had been impossible to gather any dependable information as to the river or the distance to the ocean from the few natives encountered along the banks. At last, they were

able to observe the meeting of the fresh and salt water, and thereby knew that they were about to arrive at the Outer Sea toward which they had been so long voyaging. Alexander now exhorted the oarsmen to pull with all strength, eager to reach and see this strange sea.

Ere long, some of the men began landing on the banks and shoals in quest of fresh food, when, after a time, they discovered the salt water rolling inland in great waves that broke over the beach and the boats, and great confusion ensued. Many vessels were damaged, others lost with much of the baggage and not a few lives also. After this marvellous experience, the tide began to flow out, and then many vessels were left high and dry ashore, or on the reefs and shoals, some of which careened and spilled their deck loads or sustained other damage and loss. The terror inspired in the people proved as disastrous as the collisions and strandings and careenings of the ships. In the confusion the alarmed pilots shouted orders which could not be heard, or if heard were not heeded, and, altogether it required the combined influence, wisdom and exertion of the king, admiral and subordinate commanders to bring order out of the chaos thus caused by novel terrors and forces of the tides. Night coming on, and anticipating a return of the tide, horsemen were sent down to the mouth of the river with instruction to watch for signs of its rising and to hasten back with the news, and when this was done, the people were warned and placed in readiness to man the ships and to refloat such as had been stranded, and when all this had been accomplished successfully there was great rejoicing in the fleet, so that preparations were soon begun for the works which Alexander had projected preparatory to his own and the fleet's departure. Then Alexander offered sacrifices to the gods of river and sea.

The admiral met with yet another trouble here, for his men, after being so much in salt water, broke out with sores which left scabs on their bodies, causing much distress and discouragement. But he had them rub themselves with oil which served to heal them, and thus he overcame this difficulty also, and preparations were finally finished.

"Then, as the country through which the army was to pass was dry and waterless, Alexander sent on Leonnatus in advance to dig wells. In the meantime he built several cities, and ordered

Nearchos and Onesicritus, who were experienced navigators, to sail with the stoutest ships down to the ocean, and proceeding as far as they could with safety to make themselves acquainted with the nature of the sea. The winter being now well-nigh over, he burned the useless ships, and marched homeward with his army by land," having instructed the admiral to prepare for his voyage along the same coast with the largest and most seaworthy ships, and to rejoin him finally by sailing up the Euphrates. Thus started the great king on his terrible march along the Gedrosian coast, " leaving the admiral to wait till the setting of the Pleiades should bring the change from the southwest to the northwest monsoon, and insure a quiet sea and a wind fair or on the beam" and off the coast. Bunbury says, " When we consider the total ignorance of the Greeks at this time concerning the Indian seas, and the imperfect character of their navigation, it is impossible not to admire the noble confidence with which Nearchos ventured to promise that he would bring the ships in safety to the shores of Persia, 'if the seas were navigable and the thing feasible to mortal man.'"

Nearchos wished to defer his departure till the monsoon had quite subsided, but as he was in danger of being attacked by the natives, who were no longer overawed by the presence of Alexander, he set sail on the 21st of September, 325 B. C. He was forced, however, by the violence of the weather, when he had reached the mouth of the Indus, to take refuge in a sheltered bay at a station which he called Alexander's Haven, and which is now known as Karachi. After a detention here of 24 days, he resumed his voyage on the 23d of October, but met with contrary winds which detained him off the mouth of the Indus till about the 1st of November, when, at last, the admiral set sail on what was to prove a tremendously novel yet fairly prosperous and successful voyage along the cost of this ocean and to the head of the Persian Gulf.

The army's route was lain as nearly parallel with and as near to the sea coast as practical in order to maintain, as far as possible, communication with the fleet—probably for mutual benefits and comfort. After Alexander had left the admiral and set out on his hazardous journey, he left Leonnatus with a strong force to overawe the Oreitai and await the safe passage of that coast by the fleet. These precautions seem to indicate that Nearchos expected to depend upon this coast for water and supplies in case he

was detained too long by bad weather, or met with disaster; and there are mentioned about 21 places at which the fleet stopped en route.

He encountered many dangers from rocks and shoals, and after losing three of his ships in a storm, he arrived at Cocola where he tarried some days to overhaul his vessels. It was while thus employed that he succeeded in establishing communication with Leonnatus, who had been left behind in charge of the province of the Oreitai, and obtained from him provisions, and reinforcements of men. But from this point on to the Carmanian coast, Nearchos was absolutely dependent upon his own resources, and all his patience and commanding genius and great personal force were put to the utmost test because of the violent discontent in parts of the fleet that arose out of the want of food, and the superstitious terrors encountered. Of the latter were the schools of great whales that spouted, and the mysterious perils of the "enchanted islands," in connection with which he describes himself as "the only man in all the fleet who did not fear enchantments." "At a fishing village called Mosarna, he for the first time obtained a pilot acquainted with the coast, which greatly facilitated his farther progress."

Among other strange experiences, the admiral mentions that of the terror felt by his people upon first encountering spouting whales which they finally frightened off by their loud cries and other noises; and of the many peculiarities of some of the savages met with; of sheep whose flesh was rendered unpalatable by the dried fish they subsisted on, etc. Earlier in the cruise he had been taken by surprise by hearing "in India parrots talking like human beings," and, of course, others had been equally surprised, and probably the fleet was well fitted out with these and other pets and curiosities as has been the case with naval craft in all ages—till recent conditions and orders discouraged it.

Arriving in sight of the promontory of Ros Musandam marking the Arabian side of the Persian Gulf, and disregarding the advice of Onesicritus, the pilot now of the fleet, Nearchos hugged that shore, and thus successfully sailed into the straits, and in a few more days reached the mouth of the river Anamis (now the Minab), where he moored his fleet, and gave general liberty to his men. Fortunately, as he relates, one of these men, sailor like, mounted a horse and went exploring inland a short distance where

he chanced to encounter a mounted soldier under arms who spoke Greek through whom the location of Alexander's encampment was soon made known to the admiral, who lost no time in communicating his arrival, and in reporting in person to the king.

Extracts which have survived from his log serve to give the following summary of the voyage from the western mouth of the Indus to the Persian Gulf:

> Coasting the shores of the Arabies for 80 miles, he reached the mouth of the river Arabies (now the Purali), which divides the Arabies from the Oreitai. The coast of the latter people, which was 100 miles in extent, was navigated in 18 days. At one of the landing places the ships were supplied by Leonnatus with corn, which lasted ten days. The navigation of the Mekran coast which succeeded occupied 20 days, and the distance traversed was 480 miles, though Nearchos in his log says 10,000 stadia or 1250 miles. The expedition in this part of the voyage suffered great distress for want of provisions. The coast was barren, and the savage inhabitants (fish-eaters) had little else themselves to subsist on than fish, which some of them ate raw. The Karmanian coast, which succeeded, was not so distressingly barren, but was, in certain favored localities, extremely fertile and beautiful. Its length was 296 miles, and the time taken in its navigation was 19 days, some of which, however, was spent at the mouth of the river Anamis, whence Nearchos made a journey into the interior to apprise Alexander of the safe arrival of his fleet. There was now no honor too great for Alexander to show his admiral. His delight was unbounded. He said, and confirmed it with an oath by Zeus and Ammon, that he rejoiced more at the news of the safe arrival of the fleet than at being the possessor of all Asia.

This might indicate that the fleet carried a most important cargo other than the personnel, viz., perhaps the vast Indian treasure which would be in urgent demand now that the immense treasure left at Babylon was lost having been squandered and made way with during the king's absence in the east.

Harpalos, superintendent of Alexander's treasury, was left in charge at Ekbatana of the vast treasure which had been taken thither from Susa and other captured cities of the Persian empire, but he soon took up his abode in Babylon and assumed the high office of satrap, while the king was absent in India, and there squandered untold millions in outrageous living, till, hearing of Alexander's return to Susa, Harpalos absconded with most of the balance of the treasure—5000 talents.

Nearchos visited the camp from the Anamis at the end of December, 325, and, "At the king's command he related to the

army the story of his marvellous voyage—and all were proud of the leader who had caused them to accomplish this great thing."

Alexander was unwilling that Nearchos should be further subjected to the hardships of voyaging and the attending dangers, and he asked Nearchos to find another to whom he could surrender his command, but Nearchos demurred and urged his request to be permitted to finish his task.

After extravagant and prolonged celebration in the camp and fleet, preparations were made by Nearchos to explore the coast up to the head of the Gulf, and, accordingly (January, 324), he set sail thitherward, while the army marched on towards Susa, where the fleet arrived February 24.

Nearchos had intended to sail up the Tigris, but having passed its mouth unawares, continued sailing westward till he reached the Diridotis (Teredon), an emporium in Babylonia on the Pallacopas branch of the Euphrates. He thence retraced his course to the Tigris, and ascended its stream till he reached a lake through which at times it flowed and which received the river Pasitigris (the Ulai of Scripture, and now the Karun), and proceeded up this river till the army was met near a bridge on the highway from Persia to Susa. The fleet anchored at the bridge on the 24th of February, 324 B. C., so that the whole voyage was performed in 146 days.

This time is exclusive of the eight or nine months consumed in the river cruise before the commencement of that along the seacoast, thus the entire cruising covered 13 or 14 months.

DISTANCE SAILED ACCORDING TO VINCENT

	Miles
From Jamad to the mouth of the Indus	625
Coast of Arabitai	75
Coast of Oritae	98
Coast of Ichthyophagi	480
Coast of Karmania	280
Coast of Persia	350
	1908

The voyage of Nearchos from the Indus to the Euphrates is the first event of general importance to mankind, in the history of navigation; and if we discover the comprehensive genius of Alexander in the conception of the design, the abilities of Nearchos in the execution of it are equally conspicuous.—VINCENT.

At the encampment in Susa was inaugurated the celebration of Alexander's victories, and of the joining of sea and land, and of

east and west by his enterprise and prowess—typified solemnly in the ceremonies attending the marriage of the king and 29 of his noble companions to princesses, of whom the daughter of Mentor, his own step-daughter, was allotted Nearchos. She was the daughter of Barsine—Alexander's mistress after Mentor's death.

Alexander gave them all (the brides) handsome dowries, as he did the more than 10,000 brides who had been married, by his order, to Macedonians. Nearchos and the other companions most conspicuous for personal bravery, loyal devotion, and signal achievements received golden crowns as a special mark of royal favor. Nearchos was among those mentioned as having dissuaded the king from entering Babylon on account of the predictions of the Caldaeans.

The admiral's successful voyage led to the project of circumnavigating Arabia to the isthmus of Suez, and by the end of May, 323 B. C., the fleet and army were in readiness for the expedition, but on the morning of June 2 the king fell ill. He was able to appoint the departure of his army for the 5th, and of his fleet for the 6th of June. "In the evening he went by boat to the gardens across the river, there bathed and slept." Doubtless Nearchos and other favorite companions attended him there. On the morning of the 4th he conferred with Nearchos and other officers of the fleet, and "charged them to be ready to start on the day after the next, for he counted on being well enough to set out at the appointed time. The fever steadily increased. On the 8th it assumed a dangerous form. Towards evening of June 13 he died, 30 years and eight months of age, having reigned 12 years and 10 months."

With the untimely death of the great king all immediate plans for the operations of the fleet and army were abandoned, and the whole face of the known world was changed. Alexander's house fell and great was the fall thereof.

After the death of Alexander when Perdikkas proposed a temporary leader pending the birth of the prince—Alexander Aigos, son-to-be of Roxana—"Nearchos declared it his opinion that there was no need of waiting for any other heirs, since Herakles, the son of Alexander and Barsine, had a right to the throne. But the soldiers tumultuously rejected this proposal." Prince Herakles was Nearchos' brother-in-law.

The fortunes of Nearchos shifted with the splitting up of the vast empire, and his connection with the fleet soon ceased. "His tranquil and unambitious character did not qualify him to take a leading part in the stormy dissensions that followed." Subsequently he was allotted his old districts in Asia Minor. Later he joined with Antigonus against the party of the so-called royal family in Macedonia which was led by Eumenes, and, supposedly, he shared in the downfall of Antigonus (301). "Nothing is known of his history after the year 314 B. C. when he was selected by Antigonus to assist his son Demetrios with his counsels when left for the first time in command of an army." Associated with him under the leadership of Antigonus were such old companions as Ptolemy, Peithon, and Seleukos; and one of the last references to him in the history of those bloody days is to the effect that he alone remonstrated (in vain, 'tis true) against the execution of Eumenes when his troops had treacherously delivered him into the hands of Antigonus. Vincent thinks he fell in the battle of Ipsus where Antigonus was slain (301 B. C.).

Admiral Nearchos was magnanimous, loyal, learned, patient, enterprising and courageous, evidently beloved and trusted by his men and officers, as well as by his companions in arms and his king, and he was a man well worthy to have set the high tradition of the sea, and an admirable example of the fine gifts and high traits of the ideal naval officer.

Thus was the fleet of Alexander conducted in safety from the Indus to its destination.

"ΟΥΤΩ ΜΕΝ ΑΠΕΣΩΘΗ ΑΛΕΞΑΝΔΡΩ ΕΚ ΤΟΥ ΙΝΔΟΥ ΤΩΝ ΕΚΒΟΛΕΩΝ ΟΡΜΗΘΕΙΣ Ο ΣΤΡΑΤΟΣ."

[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

A METHOD OF GUN CONSTRUCTION BY RADIAL EXPANSION

By COMMODORE S. J. BROWN (Math. C.), U. S. Navy

Early in March, 1917, when it appeared that the United States would be drawn into the European War, a proposal was made by Prof. P. L. Bridgman, of the Jefferson Physical Laboratory, Harvard University, to the Bureau of Ordnance to construct a 3-inch gun by a new method. As outlined in his plan, Professor Bridgman stated that if adopted it would produce precisely the same distribution of stress which is found in a built-up gun, but by a much simpler and less expensive process than the method generally in use.

The principle involved in the method was clearly outlined in the proposed plan as follows:

If a hollow thick tube is exposed to an internal pressure great enough to stress all the fibers to the elastic limit, when the pressure is removed the external layers will shrink back on the internal layers and leave them in a state of compression. It may be proved that the final state of stress in such a tube, which has been permanently stretched, is precisely that which would be obtained under the best possible condition in a built-up gun; but these conditions are never realized in practice.

The proposition of constructing guns is, therefore, as follows: A *single* piece of steel of the outside dimensions of the finished gun is roughly bored to approximately the required diameter; it is then stretched by one or more applications of sufficiently high internal pressure; the pressure is then released and the inside is machined to the size necessary to take the liner; the liner is inserted, thereby finishing the gun except for mountings and fittings. The very great economy of this method, both in time and in money, as contrasted with the old method, is apparent. The stretching of the gun might possibly be a matter of a day.

The reason that this very simple method is not at present in use is that the pressures necessary to produce the initial stretching are much higher than the pressures which can be handled by means commonly known. For

example, if the steel of which the gun is to be made has an elastic limit of 45,000 pounds per square inch, the necessary preliminary pressure must be as high as 120,000. Such pressures in liquids cannot be dealt with by usual methods without excessive leak.

To mention a single example, several years ago a method was projected at the Watertown Arsenal for testing guns by the application of high hydrostatic pressures, but the method had to be abandoned because pressures higher than 60,000 pounds could not be retained without leak.

In this connection I am in a position to place at the disposal of the government a technique by which pressures high enough to insure the success of the proposed method may be easily handled. For over 10 years I have been engaged in the Jefferson Physical Laboratory of Harvard University, almost exclusively in research on various effects of pressures much higher than have been previously investigated. The previous range of scientific high-pressure work has been 45,000, or at the most 60,000, pounds per square inch, whereas as a matter of daily routine I have been employing up to nearly 200,000 pounds. This, of course, has involved the invention of the methods of packing and other details of technique which are novel or at least which are not employed elsewhere to my knowledge.

The proposal to construct a gun by this novel method was referred to the Special Board on Naval Ordnance. It was found that the cold stretching of steel had been a matter of daily practical application for many years, as illustrated in the manufacture of wire and cold-drawn tubing, and it had been demonstrated many years before that the cold stretching of steel and other metals beyond the elastic limit, thereby producing a permanent set, resulted in a decided increase in the elastic strength of the metal thus treated.

The board, therefore, in view of this increased elastic strength, as well as the stresses introduced in the walls of the cylinder, recognized the practicability of the proposed method when applied to symmetrical cylinders of small dimensions, but considered that the application to large irregular masses involved in gun construction would present difficulties requiring much experimental work.

At that time the government equipment, as well as at many industrial plants, had been built up to follow the present system of manufacture of built-up guns at comparatively great speed. It was not considered expedient at a time when the greatest output of standard weapons was demanded that any changes should be made in the well-established system of manufacture of built-up guns. The Navy Department had neither the personnel nor the facilities for the experimental work involved in testing the merits

of this new theory of gun construction without interfering with the production of guns of standard design. Moreover appropriations had only recently been made for building a naval laboratory for testing just such theoretical questions, and while the value of Professor Bridgman's proposals from his long experience in laboratory work was fully recognized by the bureau, it was decided to defer such experimental work until it could be undertaken with the resources to be provided in the new naval laboratory.

While investigating the proposal of Professor Bridgman, it was found from the files of the bureau that in the fall of 1914 Md. A. H. Emery, a prominent mechanical engineer, had brought to the attention of the bureau an identical process of gun construction, covered by patents from 1903 to 1908, in which he proposed to produce initial stresses in the gun metal by a process of stretching beyond the elastic limit, employing for this purpose hydraulic pressure in the interior of the bore. As these plans were evidently presented verbally, there is no record of the action of the bureau beyond a paragraph in a letter of December 9, 1914, in which the bureau informed him that it considered his method of doubtful value, as the same results could be obtained under the present method of gun construction, by using higher pressures in the gun bore and thereby raising the elastic limit of the material if this should be considered desirable.

In April, 1917, the subject was again brought before the Bureau of Ordnance by the Naval Consulting Board, which recommended the construction of two 5-inch guns by Mr. A. H. Emery and Professor Bridgman, working in conjunction, at an estimated cost of $85,000. The proposed method was again carefully considered by the bureau, which, while conceding the importance of the proposed method, was unwilling to undertake the extensive experiments which the proposed construction of two 5-inch guns required, on the ground that attempts at that time to change the system of gun construction in the navy, in view of the pressing needs for war material, were inadvisable. The proposal was brought to a termination by the action of the Naval Consulting Board in withdrawing their letter recommending such experimental work.

On account of the very small estimated cost of the experiments proposed by Professor Bridgman, he was entrusted by the chief

of the bureau with the application of his ideas to the construction of a 3-inch 23-caliber gun, similar to the Mark III, Model 4, landing gun. Experiments were to be conducted under the general supervision of the Special Board of Naval Ordnance, and the superintendent of the naval gun factory was requested to give Professor Bridgman all possible assistance in working up the design for the forging and the necessary machinery required for producing the hydraulic pressure. Although the naval gun factory early in June took up the design of the accessories necessary for the construction of the 3-inch gun, in accordance with his ideas, it was not found practicable to complete the working drawings until the following October, when it was estimated that the forging for the press could not be made before the end of March, 1918, and its completion not before June 30. This delay was due to the urgent demands upon the gun factory for supplying standard materials which had preference over any experimental work.

The gun forging and accessories were finished early in June and taken to the Bureau of Standards, where arrangements had been made for utilizing its two-million pound Emery testing machine as the source of pressure for the experiment. It was designed to use this powerful machine, for producing the hydraulic pressure in the gun, by forcing a cylindrical 3-inch steel piston terminating in a packing into a specially constructed cylinder of 3-inch bore, thereby compressing the fluid in the interior of the cylinder, in the further end of which was a fixed packing. To this latter was attached the end of a system of hollow tubes, $\frac{1}{8}$-inch internal diameter, communicating with the interior of the gun, and conveying the pressure from the cylinder to the gun. The pressure packings in the gun were constructed on the same general design as the packings of the pressure cylinder, one fixed in the breech end of the forging, and a movable one to be shifted as desired.

The first pressure experiments were begun July 20, on the larger section of the gun tube, 7.5 inches external and 2.5 inches internal diameter. There was evidently very great friction in the movable packing of the pressure cylinder, and further difficulties in the congealing of the liquid in the tubes connecting with the gun, as the final pressure recorded by the Emery testing machine was 1,300,000 pounds which, without these two causes, should

have given 170,000 pounds per square inch in the bore of the gun. At this point the connecting pipe burst, and the pressure in the gun was thereby relieved. It was found upon examination that the 3-inch steel piston for forcing the movable packing into the

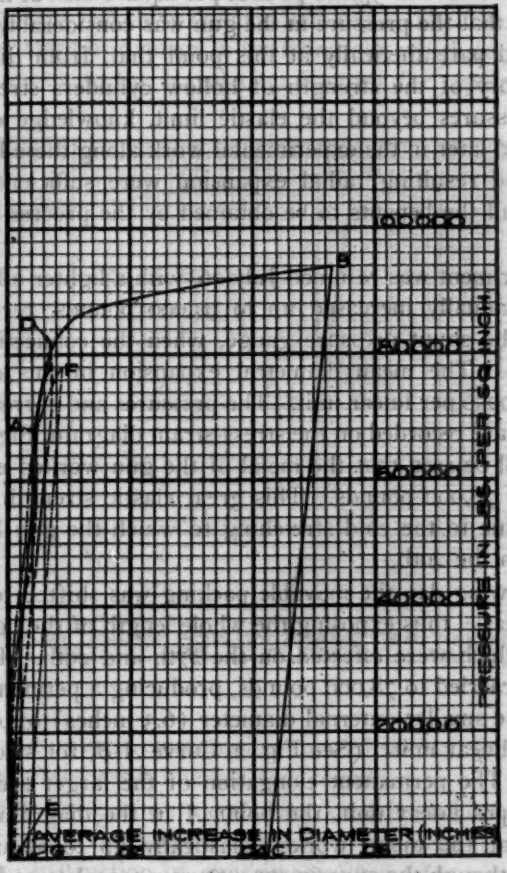


FIG. 1.

pressure cylinder was deformed, necessitating the removal of cylinder and piston to the navy yard for repairs.

The records of diametral expansion, as the pressure was gradually increased, indicate a temporary enlargement of .016 inch, or .0021 per linear unit. This elongation per unit of length of the outer layer corresponds to the elastic limit of the metal.

about 60,000 pounds, which is determined by the ratio of this elastic limit to the modulus of elasticity of steel, 30,000,000 pounds, about .002. Although the electric gauge for reading the pressures at a point in the connecting pipe just before reaching the gun recorded a pressure of 95,000 pounds per square inch at that point, it is certain that the pressure in the gun was considerably less. It may be said parenthetically at this point that, from the mathematical theory of the strength of hollow cylinders stretched by interior pressures beyond the elastic limit, knowledge of which was obtained later in the experimental work along these lines, this pressure and resulting radial expansion were sufficient to give practically all the benefits to be obtained by the process of radial expansion.

The experiment was resumed July 26, with a lighter oil, and the pressure gradually increased up to 94,000 pounds, recorded as before on the shunt pressure gauge, when the connecting pipes again burst. The mean diametral expansion in this case was .042 in, or .0056 per linear unit. The pressures and corresponding elongations are recorded on the stress-strain diagram, Fig. 1, from which it will be seen that the metal of the gun worked elastically up to about 78,000 pounds. This great elastic strength was undoubtedly due to the cold stretching to which the gun had been subjected on the 20th.

The following day the movable packing was shifted to a point near the muzzle, thus exposing the whole length of the bore to the pressures which were effected on the 27th and 29th. The pressures were carried to 78,000 pounds, producing a permanent elongation of the smaller external diameter (6.3 inches) of .075 inch, or .012 per linear unit. (See Fig. 2, Curve *A-B*, for stress-strain diagram.) The permanent elongation of the larger section was only .0004 per linear unit, the point *A* in the diagram, Fig. 1, showing that the metal worked elastically up to about 70,000 pounds. Although the experiment was now complete as far as the elastic strength of a gun of such dimensions could be carried, it was again subjected on the 29th to a pressure of 82,000 pounds, the progressive elongations showing that the metal of the gun walls was acting within the limit of its elastic strength, up to 72,000 pounds for both sections.

The cold-stretching process having terminated sastifactorily, the gun was sent to the Naval Gun Factory for machining, boring and

rifling, after which the finished gun was mounted on a regular 3-inch mount for that type of gun, and sent to the Naval Proving Ground for firing tests, which were terminated November 30, 1918. Only 14 rounds were fired, the first five the regular proving rounds for the 3-inch landing gun, the remainder with increasing pressures until the last three reached 21.8 tons. The test was then stopped on account of damage to the firing pin, which required the return of the gun to the Naval Gun Factory for repairs of this

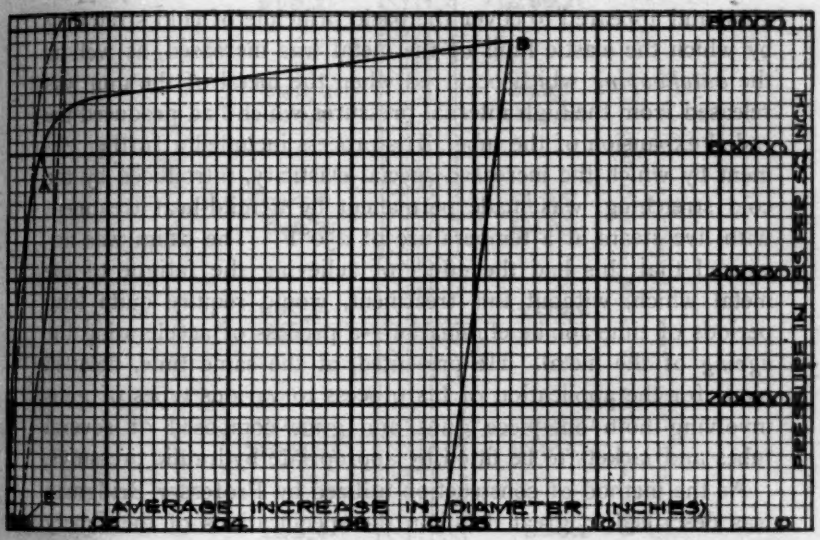


FIG. 2.

element. The gun upon examination showed no injurious effects from the high pressures in the last few rounds.

Before the firing tests were completed confidential information was received by the bureau that this system had been in use elsewhere in the construction of experimental guns for a period of about 20 years. The tests of these guns had been of such a conclusive nature that it was considered unnecessary to continue further high-pressure firings, as owing to its small caliber and the short travel of the projectile it would not have been practicable to subject it to sufficiently high pressure to tax the great elastic strength of the gun, which the experiment indicated ought to be approximately 72,000 pounds.

During the design and construction of the 3-inch gun on the plans proposed by Professor Bridgman, Mr. Emery had frequently appeared before the Special Board on Naval Ordnance advocating the extensive use of his process, on which he had obtained letters patent in 1903, and inviting attention to the fact that the construction of the 3-inch gun under Professor Bridgman's plans was an infringement of his patent rights. The specifications of his patent, the original application of which was made in 1897, embraced many practical details of accessory apparatus, and appeared to cover the basic principle of cold stretching by which the elastic limit of the metal was increased, as well as the *autohooping* which occurred when the metal of the gun was released from the high internal pressures which had produced the radial expansion of the tube. His process included a further element by which the increased special elasticity, introduced by the cold stretching, was made permanent by a mild-heat treatment with live steam at a temperature of 250°F. The claim was advanced that this had the effect of relieving the fatigue of the metal which, without this treatment, would require quite long periods of time for its elimination—a process of accelerating the *ageing* of the metal. He presented, at the same time, detailed plans for the application of his process to various types of guns involving both one-piece guns and guns composed of several tubes and jackets to be fitted by appropriate hydraulic pressures.

As the method of construction utilized by Professor Bridgman was described in great detail in the specifications of the Emery patents, which were apparently valid, and had been called to the attention of the Bureau of Ordnance in 1914, Mr. Emery was authorized early in September to proceed with the construction of a 4-inch 50-caliber one-piece gun, from designs which he had prepared and submitted to the bureau, shortly after the withdrawal of its proposal by the Naval Consulting Board.

The Tioga Steel & Iron Company was authorized to manufacture a special 4-inch forging in accordance with drawings furnished by Mr. Emery, which was completed, inspected and accepted, and sent by express to the Naval Gun Factory on December 10, 1918. The boring and machining of the forging to the required dimensions for the application of the stretching process was completed, and the gun sent to the Bureau of Standards, where the large Emery testing machine was to be utilized in pro-

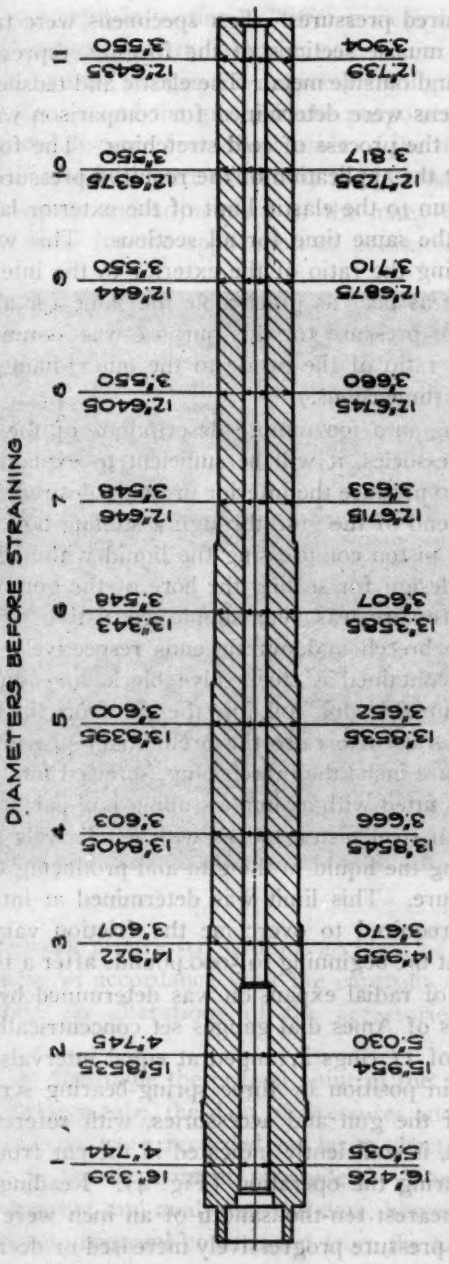


FIG. 3.—Four-inch Emery Gun, Strained January 2, 1919.

ducing the required pressures. Test specimens were taken from the breech and muzzle sections of the forging, representing the inside, middle, and outside metal. The elastic and tensile strengths of these specimens were determined for comparison with similar specimens after the process of cold stretching. The forging was so designed that the application of the required pressure for cold-stretching the gun to the elastic limit of the exterior layer would be effective at the same time for all sections. This was accomplished by making the ratio of the exterior to the interior diameter of the tube as near as practicable the same for all sections, since the interior pressure for this purpose was assumed to be a function of the ratio of the inside to the outer diameter. (See Fig. 3 for these dimensions.)

Without going into too minute descriptions of the details of the various accessories, it will be sufficient to explain that they were designed to produce the interior pressure desired, by forcing into the breech end of the gun, through a stuffing-box packing, a cylindrical steel piston compressing the liquid within the bore of the gun. The design for sealing the bore of the gun against the high internal pressure was very simple, consisting of two fixed packings at the breech and muzzle ends respectively. The one at the muzzle contained a steel valve block for admitting the hydraulic medium, "Vedol" oil, into the gun from the hand force pump which was used to raise the preliminary pressure to 6000 pounds per square inch; the breech plug, screwed into the breech of the gun, was fitted with a simple stuffing-box packing through which the 4-inch steel piston moves with a relatively small friction, compressing the liquid in the gun and producing the desired hydraulic pressure. This limit was determined at intervals, the total pressure required to overcome the friction varying from 18,000 pounds at the beginning to 5000 pounds after a few tests.

The amount of radial expansion was determined by the readings of 11 pairs of Ames dial gauges set concentrically with the gun by means of 11 rings arranged at equal intervals along the gun, and held in position by three spring-bearing screws. The arrangement of the gun and accessories, with reference to the testing machine, is sufficiently indicated in the cut from a photograph taken during the operation (Fig. 4). Readings of these gauges to the nearest ten-thousandth of an inch were made and recorded as the pressure progressively increased or decreased, and

subjected to careful inspection by differences to determine critical points in the progress of radial expansion.

In addition to the gauges the rings carried light wires running parallel to the axis of the gun, for the purpose of indicating by their measured distance from the outside of the tube whether any curvatures of the tube were caused by the internal pressure.

The setting up and adjustment of the many accessories were completed, ready for the application of pressures, December 30,

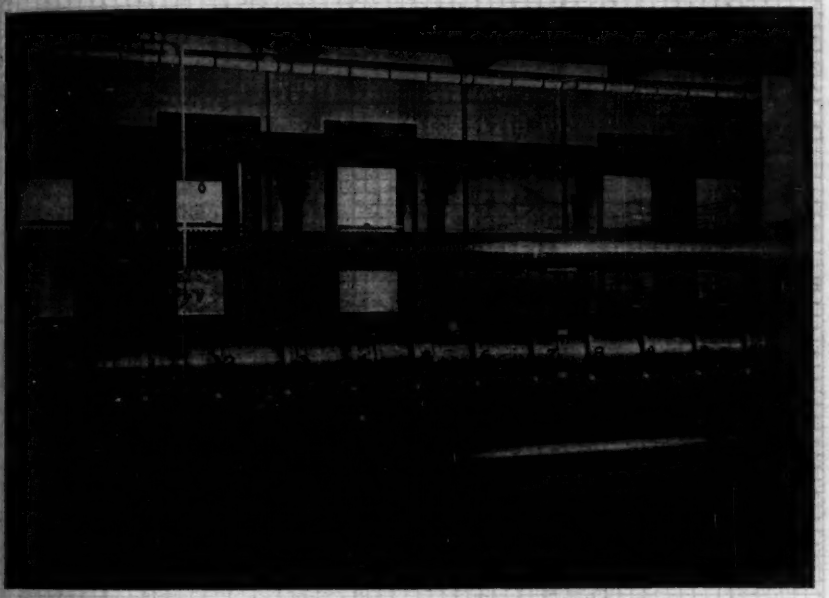
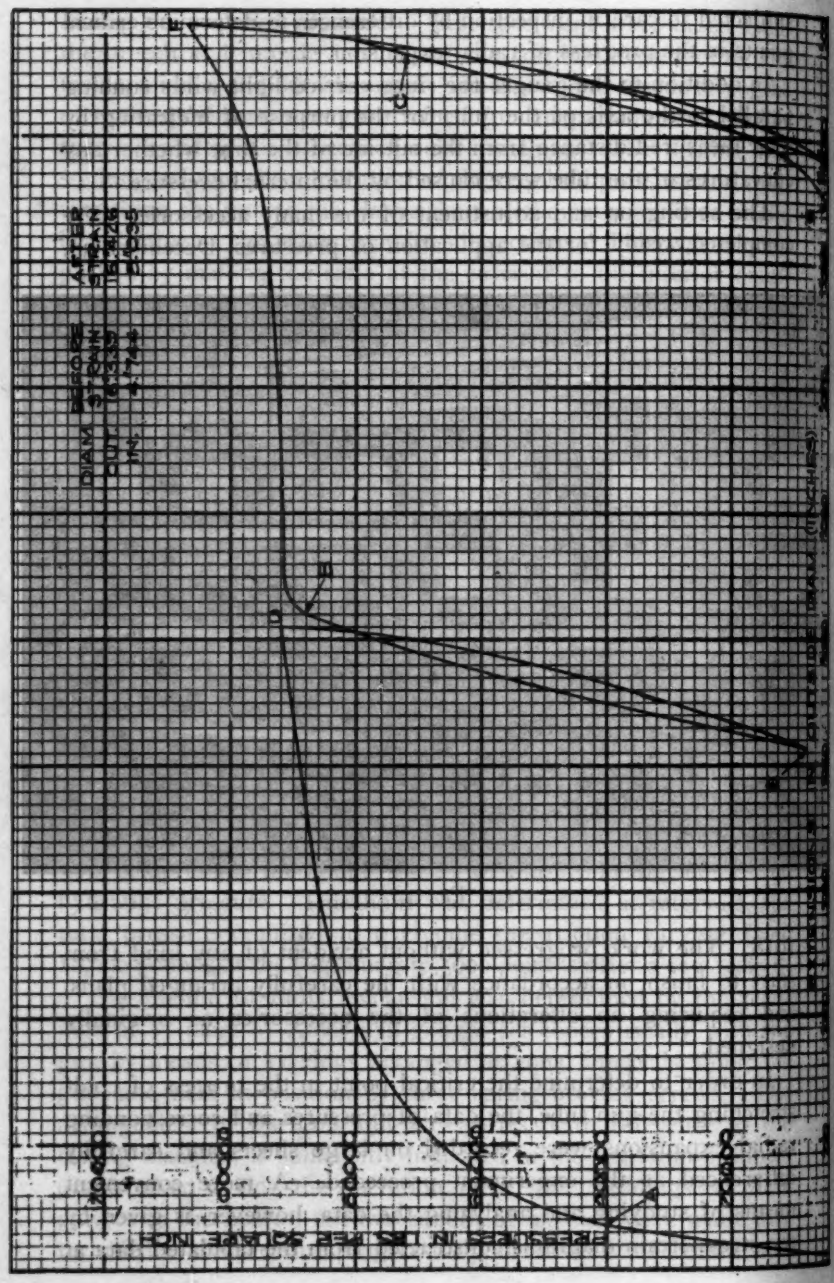


FIG. 4.

1918. The work progressed without accident of any kind from start to finish, in accordance with the carefully arranged plans, and requiring no alterations of the accessories as originally designed.

In order to determine the critical point in the process of cold-stretching the gun tube, the data of pressures and corresponding radial expansions were recorded on large sheets and carefully differenced as the experiment proceeded. A more convenient means of studying and analyzing the data, however, is given by the stress-strain diagrams constructed from the tabulated data at



the conclusion of the work. Three of the typical diagrams are given in Figs. 5, 6 and 7, and for Sections 1, 5 and 8, respectively, which show with sufficient clearness the results of the experiment. The time element, which is not shown in the diagrams, does not

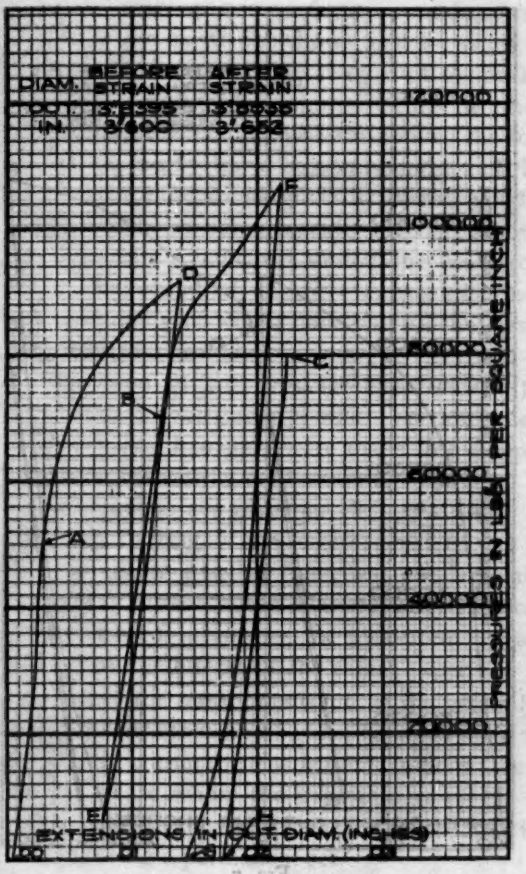


FIG. 6.

play a very important part, but it may be stated here that the application of the progressive pressures began at 9.35 on January 2, and were terminated at 5.15 the same afternoon, when the pressure recorded for the interior of the gun was 92,000 pounds. The pressure was then rather rapidly reduced until at 5.30 p. m.

the gun was without pressure. The following morning, January 3, at 9.45, the pressure was again applied and at 12.15 had reached 107,000 pounds per square inch, the highest pressure employed. This pressure was progressively diminished until at 3.45 the

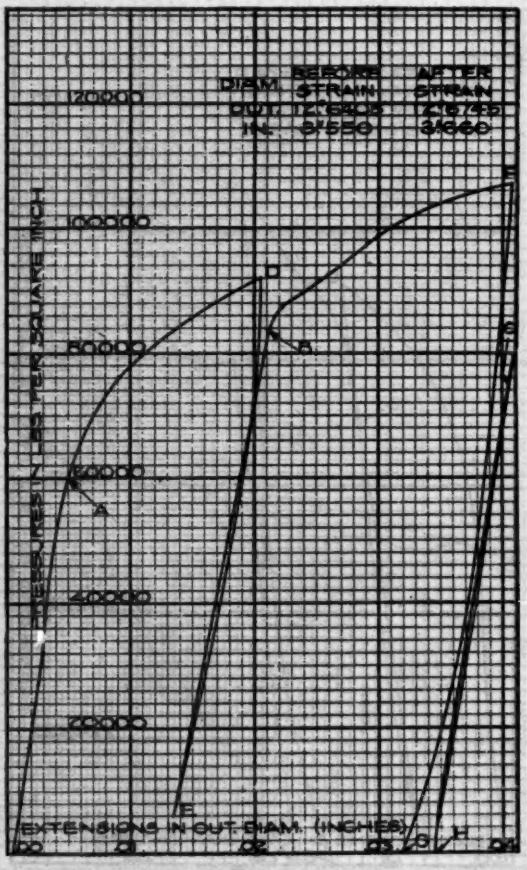


FIG. 7.

pressure was reduced to zero and the oil withdrawn from the interior. Immediately after live steam was introduced and maintained up to a pressure of 15 pounds, giving a temperature of 250° F., and this was maintained until 8 p. m.

In order to test the results of the experiment upon the elastic strength of the gun, pressures were again applied and run up

progressively to 80,000 pounds, at which point it was indicated that the elastic strength of the gun had been reached.

A study of all the diagrams constructed from the data show very clearly that at the first introduction of pressure the metal of the gun, assumed to have been without initial stresses, worked elastically up to from 40,000 to 60,000 pounds pressures, after which the more rapid expansion shows that the metal was elongating beyond the elastic limit. The amount of temporary and permanent expansion acquired is shown clearly in the diagrams, which also show that when pressure was applied the following day the tube acted elastically up to 80,000 pounds, and that the subsequent permanent elongations given by increasing the pressures up to 107,000 pounds did not apparently give any additional elastic strength. It is plainly indicated that if the heat treatment had been applied at the end of the first expansion, due to 92,000 pounds pressure, the gun would have had all the elastic strength shown in its final pressure test.

At the conclusion of the pressure experiments, the forging was sent to the naval gun factory, where accurate measurements of outside and inside diameters were made, for comparison with similar measures before the cold-straining process. The results of these measurements are given in Fig. 3, a rough drawing to scale of the gun forging. The excess metal of the breech and muzzle sections, about 4 inches long, was cut from the forging, and taken by Mr. Emery to his laboratory at Glenbrook, Conn., for the preparation of specimens, the measurements and tests of which would show the effects of the radial expansion process.

These tests were the more important, as the generally accepted theories of the elastic strength of guns, founded upon the relation of stress and strain within the elastic limit, could not be considered as applying to a case where the greater part of the metal constituting the walls of the gun had been stretched beyond the elastic limit, acquiring a permanent set.

For the purpose of ascertaining the initial stresses introduced in the gun a set of 11 rings was cut from the inner face of the breech and muzzle sections, equally spaced from the interior to the exterior of the gun. The rings, 0.2 inch square section, were cut into the face of the section, and accurately measured across several diameters while still held in place; they were then cut off and again accurately measured. The results of the measurements

from the breech section are shown in Fig. 8 from a photograph of the rings; it will be seen that the initial stresses vary from a tension of 45,600 pounds per square inch for the outer ring, gradually decreasing to zero for the seventh and increasing in tangential compression to 35,300 pounds per square inch for the inner ring. The stress was computed by multiplying the radial

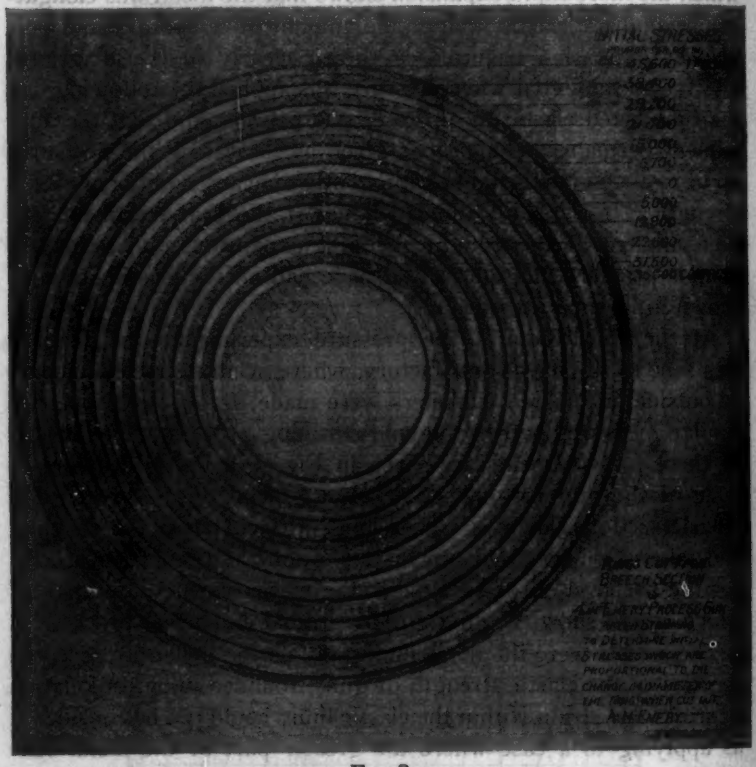


FIG. 8.

expansion of the ring, determined from the difference in diameter before and after cutting off, by the modulus of elasticity, which in the results given was taken to be about 28,500,000.

For the muzzle section the outer and inner rings measured as follows:

Before cutting—outer ring	12.560	Inner ring	4.000
After " " "	12.543	" "	4.0062
Difference	.017	.....	—0.0062
Initial tension	+38,600	.....	—44,300

In order to determine the effect of cutting down the muzzle section to dimensions of finished gun, the extra metal was turned off the exterior, and a representative section thus obtained 3.8 inches long, by 7".8013 outer and 4".0034 inner diameter, respectively. From this outer and inner test rings were cut 0.2 wide by 0.1 thick (measured radially), and the measurements resulted as follows:

Before cutting—outer ring	7.8013	Inner ring	4.0034
After " " "	7.7942	" "	4.0070
Difference	.0071	.....	—.0036
Initial Tension	+26,000	.....	—25,700

The two test rings of the size of the finished gun at the muzzle were for the purpose of determining beyond question that the metal of the cylinder walls, after cold stretching, is in a condition of initial strain represented by an infinity of hoops with just the right amount of shrinkage to give the maximum elastic strength; and that the removal of metal from the outside or from the inside leaves the remainder in a proper state of initial strain. It may be noted in the same connection that the inner ring of the breech section, shown in the preceding paragraph, is 5½ inches in diameter, approximately the dimensions of the finished powder chamber section.

The initial strains found in the various rings cut from both sections show that the metal of the finished gun is in an ideal condition of initial stress, varying progressively by infinitesimal graduations from 25,700 to 35,300 pounds per square inch tangential compression at the interior layer of the bore, to from 26,000 to 45,000 pounds tangential tension at the exterior layers. As these stresses vary progressively from compression at the interior to tension at the exterior, it is evident that the process has resulted in a condition of self-hooping in which the hoops are the successive infinitely thin layers from exterior to interior, each one shrunk upon the one next interior with a shrinkage such that all the layers (hoops), under the maximum interior pressure design, reach their elastic limit in tension together.

The initial strains thus shown are most satisfactory, not only in respect to distribution but also in respect to the amount.

The improvement in the quality of the metal is equally apparent from an examination of results yielded by test specimens taken

from the forging before and after the application of the process. These were taken from breech and muzzle sections, tangentially in planes at right angles to the axis and at such distance from the center as to have the 0".505 square sections shown as closely as possible the quality of the metal at the bore, the middle and the outside. The testing was carefully done in each case on an Emery testing machine, taking extensometer readings in ten-thousandths of an inch for the extension under load. In the following table are given the elastic strength E and the ultimate strength R in thousand pounds per square inch:

Specimens	E		R	
	Before	After	Before	After
Muzzle, outside	60	65	94	97.5
Muzzle, middle	57.5	62.5	94.5	96
Muzzle, inside	62	72	95	105
Breech, outside	56	64	91	100.5
Breech, middle	52	55	91	89
Breech, inside	40	65	91	94

The inside specimens, having experienced the greatest permanent elongation, show the greatest improvement; their stress-strain diagrams are shown in Fig. 9, where the greatest elastic strength belongs to the specimens after cold working.

At the naval gun factory the gun was given the usual finishing and rifling of the standard 4-inch guns of the same type. After mounting on the standard mount for this type of gun, it was sent to the Naval Proving Ground for test firings early in March, 1919. In order to furnish comparison with the best type of standard 4"/50 gun, the firings were to be carried on in conjunction with a standard Mark IX-5 gun No. 3479, made by the American & British Manufacturing Company, Bridgeport, Conn. In the inspection of the two guns previous to the firing, by members of the Special Board on Naval Ordnance, it was noted that rifling of the Emery guns was much rougher in appearance than that of the standard gun, and had several small gouges and evidence of tool chattering in the rifling, while that of the standard gun was very smooth and highly polished.

Investigation in the gun shop disclosed that the rifling of contract guns in general is admitted to be superior in appearance to rifling done in the gun shop, but not in efficiency. This is due to the fact that the gun shop does not put in the time on the operation that outside contractors do, since it has been determined that

a lesser polish is satisfactory for service purposes. Normally, the gun is lapped after rifling by both a lead slug and a copper slug, which are forced into the rifling by spring pressure. It is the copper lapping which puts on the final brilliant finish, and in the

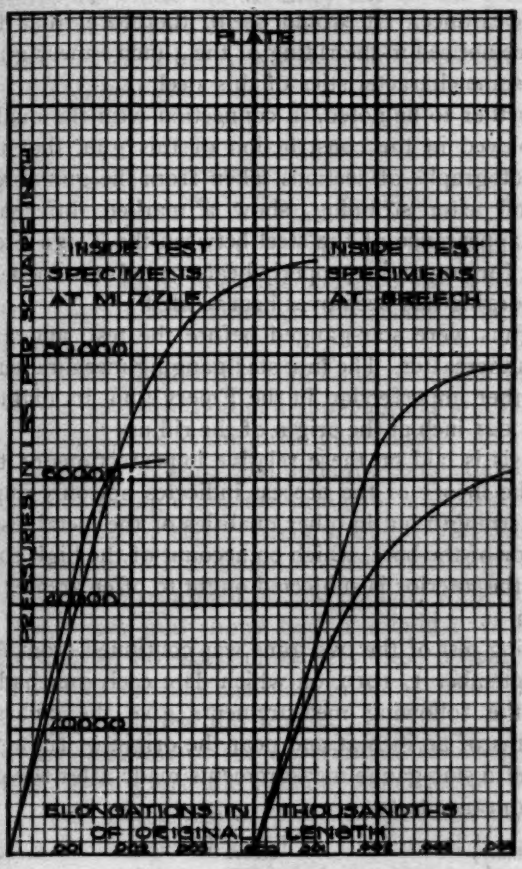


FIG. 9.

case of the Emery gun the urgency of the order made it seem expedient to the gun shop to omit the copper lapping and lap out only with the lead slug.

Further inquiry brought out the information that representatives of the American & British Ordnance Company, the manufacturers of the standard gun noticed above, had stated that they

had found great difficulty in satisfactorily machining gun forgings made by the Tioga Steel & Iron Company; that they had tried varying the speed of the lathe, together with the temper and hardness of the tool used, and that, notwithstanding their best efforts, the machined gun forgings of this company always had a rough appearance. It would seem, therefore, that the rough appearance noticed in the rifling of the 4-inch Emery gun was due partly to some characteristics of this steel.

It is further to be noted, in connection with the quality of the steel employed in the construction of this gun, that the microscopic photographs of sections taken from the gun forging, both before and after straining, show a marked difference in the granular appearance of the steel between the Tioga Steel & Iron Company forging and a properly heat-treated specimen, indicating that the forging had been over-heat treated.

Both guns were star-gauged before the test, and after every 60 rounds thereafter. The first star-gauging measurement brought out a further imperfection in the Emery gun, its diameter being larger by .021 inch at the origin of the rifling.

Emphasis is laid on these relative imperfections of the Emery gun, as the theory of the process indicates not only improvement in elastic strength but in other qualities of the metal, especially at the interior of the bore, which on account of the high compression to which the interior is subjected ought to offer greater resistance to erosion.

The firing test of the two guns was continued from April 16 to about September 1, 1919, on which date each gun had fired 599 rounds; the following measurements give the enlargement in thousandths of an inch at and near the origin of rifling, resulting from careful star-gauge measurements made after the completion of the endurance tests:

Emery	Distance from breech	Standard
136	42.13	161
136	42.25	154
128	43.13	139
71	52.00	77

A visual inspection of the bore of the two guns shows the lands at the origin of the rifling nearly worn away for about 8 inches or a foot. At the muzzle, however, the lands are still in serviceable condition, although the gouges and tool markings in the

rifling of the Emery gun still persist. Both appear still fit for further service, especially when compared with a standard Mark IX-5 No. 1302, in which, after 544 rounds, the lands are almost gone throughout the bore from origin to muzzle.

The extent to which the accuracy life of the guns has been reduced may be inferred from the results of firing the last five rounds of the series, using A & B shell, in comparison with a new Mark IX-5 standard gun:

Gun	Velocity	Pressure	Range
Emery	2759 = 13	14.32 = .33	9215 ± 90
Standard	2768 = 25	14.61 = .24	9225 ± 98
New	2862 = 11	16.43 = .21	9522 ± 40

The loss of about 100 f. s. in velocity, two tons in maximum pressure, and 300 yards in a range of 9500 yards, would not preclude their further use, although the accuracy of fire is considerably less.

Notwithstanding the further endurance indicated for both guns, it was decided to make thorough star-gauging and taking of impressions of their bore at the naval gun factory, where they were sent on September 11, 1919; and upon the completion of this work to subject them to high-pressure firing for the purpose of testing the apparent superior elastic strength of the gun constructed by the Emery process. The design of the standard gun calls for a maximum elastic strength of 56,000 pounds, while the construction of the Emery gun shows that it should have a maximum elastic strength of 80,000 pounds. As these tests may be somewhat delayed, permission has been given by the bureau to publish a brief description of the process.

During the progress of the experiments resulting in the construction of these guns, the general principles of the proposed method, as well as the various practical questions involved, were examined and discussed at length by the Special Board on Naval Ordnance, to which were added the superintendent and other officials of the naval gun factory, as well as officers of the bureau and the Naval Proving Ground, having general experience and knowledge of the subject of gun construction.

The conclusions of the board, unanimously adopted at its last meeting on March 5, 1919, recommended the immediate construction at the naval gun factory of type 6"/53 guns, utilizing the facilities at the Bureau of Standards, and at the same time the

development of plans for installation of the necessary facilities at the naval gun factory for construction of guns of this type as well as larger guns. The Bureau of Ordnance has approved these recommendations and has adopted for the official designation of the process the name of "Radial Expansion."

A brief historical résumé of the basic principles involved in the proposed method will show that it is not such a startling innovation as might be imagined from the description of the two experiments already described. These principles are:

1. Special elastic strength induced by cold working.

2. Fixing or ageing of the increased elastic strength by a mild-heat treatment after cold working.

3. Radial expansion; resulting in a condition of initial strains, which are only partially realized in the methods now in general use; that is, shrinking on jackets and hoops previously expanded by heat, or wire winding.

1. *Special Elasticity.*—The development of a special elastic strength in metal by cold stretching was first definitely demonstrated and announced by Colonel Rosset, as a result of experiments at the Turin Gun Factory in 1874, upon test specimens cut from Petin-Godet hoops and other selected specimens of steel for gun construction. A summary of these experiments is contained in "Notes on Construction of Ordnance" (Army Ordnance Bureau No. 11), published in 1882. The results showed that if a test bar be subjected to a tensile stress greater than its limit of elasticity, it will not undergo, when subjected to a subsequent stress less than the above, any permanent elongation and, therefore, its elastic power has been increased. It was further indicated by the great regularity in the elastic elongations, and their proportionality to the stresses, that this special elasticity might be increased with the increase of the stresses nearly up to the point of rupture.

A clear idea of this development of *special elasticity* will be readily appreciated from the stress-strain diagram of test specimens subjected to cold stretching. When a test bar is subjected in a testing machine to a gradually increasing tension, there is a measurable elongation of the bar at each increment of tension, which is proportional to the tension until the *elastic strength* of the metal is reached. Within this limit, if at any instant the tension is removed, the bar recovers wholly its original dimensions.

If the tension and corresponding elongation are plotted, the former as ordinates and the corresponding elongations per unit of length as abscissæ, the resulting diagram will be a straight line, up to a certain point defined as the elastic limit, as illustrated in Fig. 10, in the sections *OA, OB* and *OC;* but as the load is gradually increased beyond the elastic limit, this regularity of behavior suddenly ceases, the elongation for a given increment of tension increases more rapidly than the tension, and if the load is now removed the bar contracts somewhat, but is not restored to its

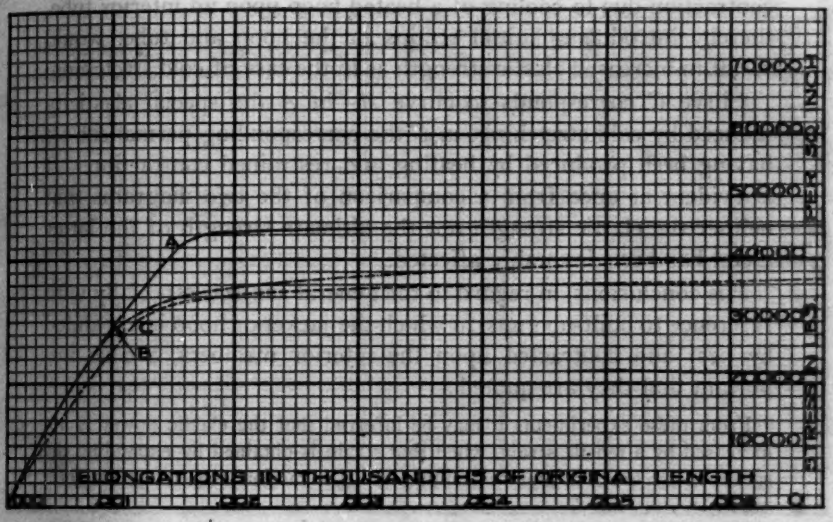


FIG. 10.

original dimensions—it has acquired a permanent elongation or set.

If the bar, after a period of repose, is again subjected to the load which resulted in the permanent set, it will be found that the elastic limit of the specimen has been increased—that the constant ratio of load to elongation will hold up to the load which produced the permanent set.

The dotted curve *B,* from Colonel Rosset's data, is formed from the mean values of stress and corresponding elongations of several specimens which were subjected to loads leading to rupture. Other specimens of the same material were subjected to a stress sufficient to cause a permanent elongation, and the increase

in the elastic limit of these specimens is shown in curve *A*, by the increase of the ordinate for the point *A* over that of the point *B*.

As these experiments were conducted for the purpose of studying the best method of constructing built-up guns, Colonel Rosset naturally inquired if the same results, in regard to special elasticity, would be obtained with specimens in which the permanent set had been produced by elongations due to heating and subsequent cooling, the contraction being restrained in order to produce the permanent set. The explicit problem was to determine if the contraction due to cooling of a heated hoop upon an interior tube, thereby introducing initial strains in the hoop and tube, would result in increased elastic strength as in the case of cold stretching.

Curve *C* corresponds to curve *A*—in *A* the special elasticity induced by cold stretching, in *C* the corresponding permanent set having been produced by heating and restrained contraction. It is evident at once from a comparison of the two diagrams that neither the elastic strength nor the ultimate strength of the latter metal has been favorably affected.

His conclusions, in regard to the general subject, especially with reference to built-up guns, in which the jacket or hoop is expanded by heat and contracted upon the interior members, are so important that they are quoted:

> From these experiments it may be inferred that the elastic power is not increased by a tensile strain, when that strain is obtained by expanding the specimen by heating, and restraining the contraction consequent on cooling; . . . .
>
> Wishing to develop the elastic power in order to obtain greater elastic elongation, it will be necessary to have recourse to mechanical tensile strains, and not to the method of restraining the contraction consequent on cooling.

In Fig. 11 is illustrated the effect of cold stretching upon the development of *special elasticity* in the case of two specimens of mild steel tested by Mr. A. H. Emery. These two diagrams are selected from a large number of similar ones, the results of Mr. Emery's experiments made on the bridge links used in the construction of the St. Louis Bridge. The diagram shows that in the dotted curve the metal reached the elastic limit at the point *F*, corresponding to about 40,000 pounds of tension, and began to show the more rapid elongation beyond this point up to *G*, 46,000 pounds, when the load was removed. The permanent elongation

for this load was about .009 per linear unit. After a brief period of time, the load was again applied and the strength line *H-I* shows that the limit of elastic strength has been increased up to the stress which produced the permanent set. From that point on the metal gradually elongates, and rupture takes place at 77,300 pounds. In the second diagram the elastic limit was reach at a slightly lower point, and the load was continued with the elongations indicated up to the point *C* at 62,000 pounds per square inch, with momentary elongation of .0413 and a permanent elongation

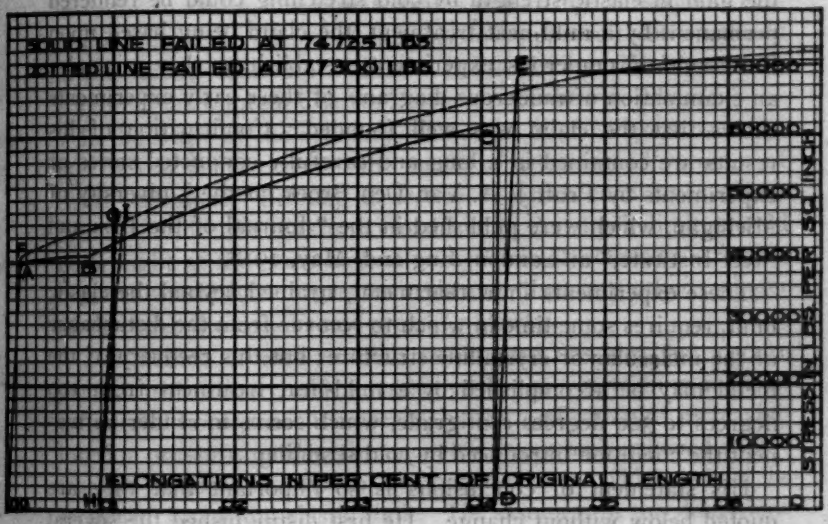


FIG. 11.

of .040. In this specimen the load was allowed to remain for a period of a week, when it was removed; upon the gradual application of the load, the curve clearly shows the increased elastic limit up to 70,000 pounds.

2. *Tempering or Ageing.*—The question of the permanence of the special elasticity induced in steel by cold working has been a subject of much experimental investigation during the past 25 years. Some investigators have claimed, notably Prof. J. B. Johnson, of the University of Wisconsin, that the gain in special elasticity, due to tension, is accompanied by a loss of elasticity in compression. These conclusions are stated in a text-book for engineers recently published by Professor Johnson, under the

title "The Materials of Construction, a Treatise for Engineers on the Strength of Engineering Material," wherein he stated:

Both wrought iron and rolled steel, in their normal state, have "apparent elastic limits" in tension and in compression numerically about equal. If this material be stressed much beyond these limits, however, in either direction, its elastic limit in this direction is numerically raised to about the limit of its greatest stress, while the elastic limit in the opposite direction is greatly lowered or even reduced to zero.

In the specifications of Mr. Emery's patent, it was claimed that the gain in elastic strength by cold stretching could be rendered permanent by a mild-heat treatment, the claim being based upon the result of numerous experiments establishing this principle; an examination of numerous diagrams of these early experiments shows that the claim was well founded. Confirmation of his results are contained in a long and carefully conducted series of experiments by Prof. J. A. Van Den Broek, at the University of Michigan, which were published in the "Journal of the Iron and Steel Institute," at London, England, May, 1918.

These experiments show that metal, strained beyond the elastic limit, requires some time in which to recover from the disturbance of the molecular or crystalline structure; but this recovery of the metal may be accomplished by a mild-heat treatment from 100 degrees to 300 degrees centigrade, which seems to render permanent the condition introduced by cold straining.

His statement of conclusions is so important that they are quoted below without change. He first distinguished the several kinds of cold working, and the resulting special elasticity as being of different *direction* and *sense, i. e.,*

Tension and *compression, same direction*
Tension and *compression, opposite sense.*
Positive torsion (+shear), *same direction.*
Negative torsion (−shear), *opposite sense.*
Torsion and *tension,* respectively, of *different directions.*

(1) When mild steel is cold-worked and properly aged or tempered, and subsequently tested in the *same sense* as that of cold working, its elastic limit may be raised more than 100 per cent and from 10 per cent to 20 per cent beyond the stress at which cold working was discontinued.

(2) When mild steel is cold-worked in one *direction* and properly aged or tempered, but tested in either one of two senses of a different direction, then its elastic limit may be raised some 50 per cent.

(3) When mild steel is cold-worked in one sense and properly aged or tempered, but tested in the opposite sense, then the elastic limit remains at the value of the original elastic limit, but the yield point is raised.

(4) When mild steel is cold-worked in any direction or sense, without *ageing* or *tempering*, then the elastic limit falls below the value of the original elastic limit, often down to zero.

(5) Tempering cold-worked steel at temperatures from 100° C. to 300° C., or ageing it, has a tendency to perfect its elastic properties. Tempering merely accelerates the effects of time.

3. *Self-Hooping Due to Radial Expansion.*—The first reference to the subject of cold-stretching a cylinder beyond the elastic limit, in order to realize the initial strains due to the subsequent contraction upon the release of the pressure, appears to be contained in the second volume of "*Limite D'Élasticité et Résistance a la Rupture,*" by Captain Charles Duguet, published in 1885.

In the study of the ordinary method of built-up guns by hooping, he was led to consider the means of attaining a "cylinder of equal resistance," defining it as one in which each layer of the cylinder, under the maximum load within the elastic limit, should be brought at the same instant to its limit of elasticity. Such a cylinder would have a greater resistance than any other cylinder of the same dimensions and weight of metal.

The method of wire-winding approached this idea, but a more perfect realization could be obtained by cold-stretching a given cylinder of homogeneous material, by the application of increasing interior pressure until each concentric layer had acquired a permanent deformation up to the outside layer, which would be stretched just to its elastic limit. He assumes, in the dilatations of such a cylinder, as in all deformations of a non-porous solid, in which the density varies very little, that we may consider the volume constant without any appreciable error, so long as the dilatations do not exceed 0.03 per unit length. As a result of this assumption, the relative dilatations of the various layers are inversely proportional to the square of the radii, or

$$R^2 \frac{\Delta R}{R} = r^2 \frac{\Delta r}{r}.$$

He describes clearly the elastic resistance of such a tube primitively deformed:

When a tube has been sufficiently deformed by an interior pressure P_0, the elastic limit is passed at every one of its points. If the pressure ceases to act the tube is deflated, contracts upon itself; but the total deformations pro-

duced in the different layers being nowhere proportional to the elastic forces which accompanied them, all these forces cannot vanish at the same time; the exterior layers remained stretched and exert upon the interior layers a radial pressure; inversely, the interior layers react upon the others and are compressed tangentially, just as happens in a hooped cylinder. Under these conditions, a new pressure inferior to P_0 will produce only elastic deformations. . . . .

Under the new action of the pressure P_0, each layer suffers a deformation corresponding to its actual elastic limit; and p and t being the pressure and principal tension developed at any point whatever, we shall have at each point the following relation:

$$mp + nt = G.$$

G, which depends upon the initial deformation, varies from one point to another and diminishes from the exterior to the interior.

In his theory of the resistance of metals, G is defined as the coefficient of "shear" (sliding, *glissements*), and is approximately six-tenths of the elastic limit of the metal for simple traction:

The interior pressure capable of deforming a tube so that the exterior layer shall be just at its elastic limit E is certainly superior to

$$P_0 = \frac{nE}{n-m}\left\{\left(\frac{R_1}{R_0}\right)^a - 1\right\},$$

but it differs from it very little; for, at each point, even at the interior layer, the deformations produced are so small that the elastic forces developed are very little different from those which correspond to the natural limit of elasticity.

In the formula above quoted, n is equal to 0.59, m is equal to 0.41, and a is equal to 0.3. He applies his formula to an unstrained cylinder and to the same cylinder which has been strained as above described.

Let us take as an example a steel cylinder of one caliber thick, in which the metal has an elastic limit of 30 kgs. in simple traction. The natural elastic resistance is P_0 equal to 1580 atmospheres; every pressure superior to this will produce a permanent deformation. A pressure slightly superior to

$$P_0 = \frac{18k}{0.18}\left\{3^{0.3} - 1\right\} = 39k,$$

per square millimeter, say about 4000 atmospheres, will produce permanent deformations at every point and leave the exterior layer stretched just to its natural elastic limit; its elongation will be

$$\frac{E}{M} = \frac{30}{20{,}000} = 0.15\%;$$

the interior layer will suffer under the same pressure a dilatation nine times as great, or 1.35 per cent.

Thus, by a simple initial interior dilatation of 1.35 per cent, produced solely by interior pressure, we will increase the elastic resistance of a soft-steel tube one caliber thick from 1600 to 4000 atmospheres and we will obtain thus a cylinder more resistant than any other hooped cylinder of the same material and the same dimensions, as we have realized the solid of perfect equal resistance already defined.

The assumption of Duguet, given in the preceding paragraphs for the relations of the pressure and resulting tension at any point in a hollow cylinder, is equivalent to

$$t+0.7p=E,$$

where E is the initial elastic limit of the metal before cold working.

Beginning in 1909, extensive investigation of the subject has been made at the Central Laboratory of the French Navy, under the name of "*Autofrettage*," literally self-hooping or auto-hooping. The mathematical theory of "*Autofrettage*" has been developed by Ingénieur-Général L. Jacob, and very recently published in a two-volume work entitled "*Résistance et Construction des Bouches à Feu, Autofrettage.*" He assumes that the elastic limit at any point is reached when the relation of the interior pressure and the resulting tension is

$$t+0.3p=E,$$

and calls attention to the fact that the theory of Duguet gives too small an amount for the maximum resistance of a cylinder which has been built by the process of autofrettage.

He also notes, further, that the adoption of the theory that the elastic limit of the metal is reached when at any point

$$t+p=E$$

leads to a still smaller resistance for a given cylinder.

The latter assumption is the basis of the mathematical investigations of Colonel Malaval, under whose direction the experimental work at the Central Laboratory of the French Navy has been carried on.

Each of these eminent authorities appears to establish the correctness of his respective theory upon the result of experiments and investigations made at the central laboratory. Both, however, call attention to the fact that the pressure of autofrettage is limited to such a pressure that, upon the return of the stretched cylinder to a state of rest, there shall not be developed any new permanent deformations in the interior layer.

Whichever theory is elected, the permissible pressures are considerably less than those to which the Emery gun was subjected. The examination of the initial strains of the rings cut from the metal of the Emery gun apparently does not furnish a complete criterion in this respect. If there has been introduced new permanent deformations in the interior layers upon the return to rest, they do not appear to be indicated by the intial strains found in the 24 test rings.

It is not intended in this description of the construction of the two experimental guns to discuss or to develop the mathematical theory of the elastic strength of guns constructed by the method of radial expansion, which will necessarily be deferred until the basic assumptions are more definitely established by experiment, nor is it necessary to do this in order to utilize the method in the experimental construction of either single-piece or built-up guns of several hoops and tubes.

In the design of guns to be constructed by this method, the elastic-strength curve is determined from the powder-pressure curve, just as in standard guns now in use; whether the gun shall be a single piece or a compound gun will be determined by the size of the forging which it is practicable to make from a metallurgical standpoint, and convenience in the machining of the gun. From the theoretical standpoint, the construction of a 16-inch gun should offer but few difficulties outside those to be expected in a smaller single-piece gun. The various parts are machined to a close fit with as little play as possible, the parts are assembled and the pressure is applied just as would be done with a smaller single-piece gun, as the pressure necessary to realize the elastic strength desired is a comparatively simple function of the ratio of the inside to the external radius.

Sufficient experimental work has already been carried out at the naval gun factory to demonstrate that the pressure plant installation can be constructed in a convenient form and at a relatively small cost, as the extensive experiments conducted at the French Naval Laboratory, under Colonel Malaval, have shown that all the elastic strength desirable can be obtained by pressures giving a permanent deformation of the interior layer not exceeding .03; an amount very much smaller than was experienced in the case of the Emery gun, due to the attempt to carry out the process by stretching the whole gun with the same pressure for all sections.

[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

GRAPHICAL METHOD FOR REDUCING LATITUDE SIGHTS TO MERIDIAN

By RICHARD D. FAY

The alignment chart here given furnishes a simple means for working an ex-meridian sight graphically. The theory on which this method is based is the same as that given in Bowditch's Navigator, and the work performed with the chart is the same as that done with tables Nos. 26 and 27 in Bowditch. The advantages of the graphical method are that the work may be done more rapidly and with equal accuracy (no interpolation being required) and that the degree of precision which is possible with any data can be estimated at a glance.

The theory of the method is as follows:

Let

Z = Zenith distance of body.
d = Declination of body.
L = Latitude of observer.
t = Hour-angle of body.

The fundamental relationship between these quantities is

$$\cos Z = \sin d \sin L + \cos d \cos L \cos t.$$

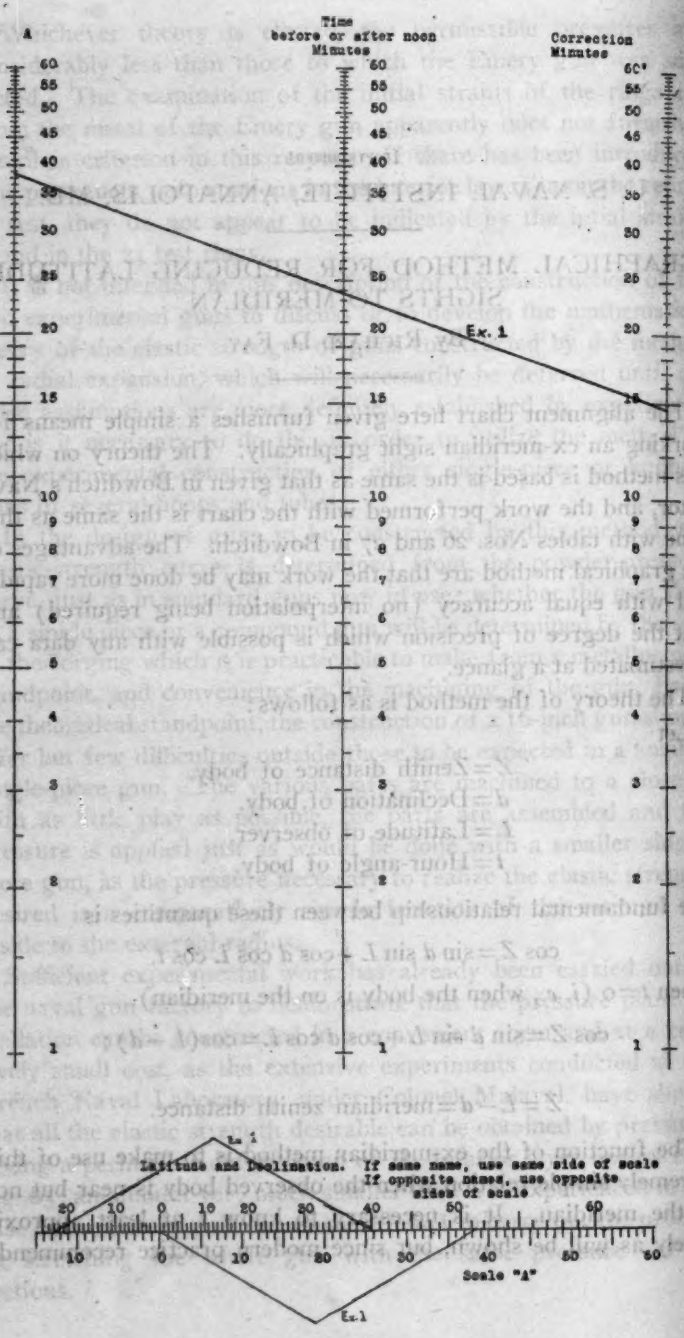
When $t = 0$ (*i. e.*, when the body is on the meridian),

$$\cos Z = \sin d \sin L + \cos d \cos L = \cos(L - d);$$

or,

$$Z = L - d = \text{meridian zenith distance.}$$

The function of the ex-meridian method is to make use of this extremely simple relation when the observed body is near but not on the meridian. It is necessary to know t at least approximately as will be shown, but since modern practice recommends


A
Time
before or after noon
Minutes
Correction
Minutes
Ex. 1
Latitude and Declination. If same name, use same side of scale
If opposite named, use opposite
sides of scale
Scale "A"
Ex.1

calculating the time of the meridian passage rather than taking the greatest observed altitude, the ex-meridian sight requires no extra work except that performed on the chart, which can be done in about 10 seconds.

If Z_0=meridian zenith distance$=L-d$.

Z=zenith distance found from observed altitude.

Then the "reduction," R, to be applied to the observed altitude is $Z-Z_0$.

Since
$$Z=Z_0+R,$$
$$\cos(Z_0+R)=\sin d \sin L+\cos d \cos L \cos t;$$

or,

$$\cos Z_0 \cos R-\sin Z_0 \sin R=\sin d \sin L+\cos d \cos L \cos t.$$

This relationship involves no approximations.

When, however, t is small, R also must be small, so that

$$\left.\begin{array}{ll}\cos R=1 & \text{(approximately)}\\ \sin R=R & \text{"}\\ \cos t=1-\frac{t^2}{2} & \text{"}\end{array}\right\} R \text{ and } t \text{ in radians.}$$

$$\therefore R=\frac{\cos Z_0-\sin d \sin L-\cos d \cos L+\cos d \cos L \cdot \frac{t^2}{2}}{\sin Z_0}\text{ (approx.)}.$$

Substituting for Z_0 its value, $L-d$,

$$R=\frac{\cos(L-d)-\cos(L-d)+\cos d \cos L \cdot \frac{t^2}{2}}{\sin L \cos d-\cos L \sin d}$$
$$=\frac{t^2}{2(\tan L-\tan d)}.$$

If R is expressed in minutes of arc and t in minutes of time

$$\left(\frac{\pi}{180}\times\frac{1}{60}\right)R=\left(\frac{\pi}{180}\times\frac{15}{60}\right)^2\frac{t^2}{2(\tan L-\tan d)};$$

or,

$$R=\frac{t^2}{\frac{96}{\pi}(\tan L-\tan d)};$$

or,

$$R=\frac{t^2}{A} \text{ where } A=\frac{96}{\pi}(\tan L-\tan d).$$

The two operations necessary to find the reduction of altitude are then (1) to find A which is the reciprocal of reduction when $t=1$ minute. This involves L and d; (2) to find reduction from A and t.

The graphical method for finding A is simply to scale off the difference between two tangents on a modified scale.

The alignment chart is arranged to give R as follows:

Since

$$R=\frac{t^2}{A},$$

$$\log R=\log t^2-\log A;$$

or,

$$\log t=\frac{\log R+\log A}{2}.$$

That is to say, $\log t$ is the average of $\log R$ and $\log A$. If a straight line intersects three vertical lines spaced equally, the intercept on the inner line measured from any horizontal base will evidently be the average of the intercepts on the outer lines measured from the same base. Therefore, if three lines with equal logarithmic scales be used, the outer lines representing R and A, and the inner one t, corresponding values of R, t, and A will always lie on a straight line. Hence R is readily found when t and A are known.

The procedure in using the alignment chart is as follows:

I. To find A. With the dividers on the upper horizontal scale take the distance between the latitude and declination (approximate values) on same side of zero if they are of the same name or on different sides if they are of different name. This distance measured on lower horizontal scale gives A.

(Alternative method: Find numbers on lower horizontal scale opposite latitude and declination on upper horizontal scale. If L and d are of the same name find the difference of the numbers; if of different names find the sum of the numbers. The result will be A.)

II. From position by dead reckoning calculate the watch time of meridian passage. To insure taking the sight within the time interval that this method holds good, plan if possible to take the sight so that the time interval t in minutes does not exceed A.

Place a straight-edge across the vertical scales to intersect left-hand scale at A and middle scale at t. The intersection with the right-hand scale will give the required reduction in minutes of arc.

Example 1.—January 2, 1920, in Lat. 40° N., Long. 45° W. (position uncertain) corrected central altitude of sun was 27.° 00′ at G. M. T. $2^h\ 40^m\ 00^s$.

	h	m	s	
G. M. T.	2	40	00	
Eq.		−3	43	
G. A. T.	2	36	17	(Jan. 2)
Long.	3	00	00	(West or −)
L. A. T.	23	36	17	(Jan. 1)
	24	00	00	
t		23	43	say 23¾ min.
Decl. (d)		22	59.8	S

With dividers: 40 to right of zero and 23 to left of zero gives $A=38\frac{1}{2}$.

With straight-edge: Line through $38\frac{1}{2}$ left and $23\frac{3}{4}$ center gives $14\frac{3}{8}$ right.

$R=14.7'$.

Ex-merid. alt.	27°	00′	
R		14.7	
Merid. alt.	27	14.7	
	90	00.0	
Z	62	45.3	N.
d	22	59.8	S.
L	39	45.5	N.

If A had been found using this value for L, A would have been about 38.4 which gives R very little change. Also, by moving the straight-edge keeping A $38\frac{1}{2}$ it will be seen that a variation in t of one minute produces a change in R (and hence in L) of less than $1\frac{1}{8}$ miles. Therefore, for this example where A is large there is little difficulty in getting accurate results. Actually if no approximations are used, the latitude is found to be 39° 45.6′, a difference of only 600 feet.

Example II.—January 2, 1920, in Lat. 30° S., Long. 45° W. by account corrected central altitude of sun 81° 50.6′ at $2^h\ 47^m$ G. M. T. From data of previous example:

$t = 16^m\ 43^s$.
$d = 22\ \ 59.8$ S.

With dividers: From 30 to 23 both to right of zero gives $A = 4.8$.

With straight edge through $A = 4.8$ and $t = 16\frac{3}{4}$, R is found (with difficulty) to be about 59′, very slight changes in either A or t making large changes in R.

Ex-merid. alt.	81°	50.6′	
R		59.0	
Merid. alt.	82	49.6	
Z	7	10.4	S.
d	22	59.8	S.
L	30	10.2	(True L is 30° 14.8′)

If A is corrected by using this value for L, the error will be reduced to about 2′, but there is considerable uncertainty in the method still.

If now another sight be taken when $t = 5^m$; corrected alt. becomes 82° 40.0′.

R (using $A = 4.8$) is found to be 5.2.

Obs. alt.	82°	40.0′	
R		5.2	
Merid. alt.	82	45.2	
Z	7	14.8	S.
d	22	59.8	S.
L	30	14.6	S.

which is within the ordinary error of observations.

For a star sight the ex-meridian method is of particular importance since it is unusual to have a good horizon for more than a short time when the stars are visible. The hour-angle t is then the difference between the right ascension (R. A.) of the star and the local sidereal time. In other respects the procedure is the same as for the sun.

Example III.—February 10, 1920, in approximately Lat. 5° S., Long. 100° E. had good horizon at about 6.45 p. m. ship's time (G. M. T. 0^h by chronometer).

	h	m	s	
Right ascension mean sun at G. M. noon	21	17	05.9	
Longitude	6	40	00.0	E. or +
	27	57	05.9	
	24			
Local sidereal time (L. S. T.) corresponding to noon, G. M. T.	3	57	05.9	

In nautical almanac under "Apparent Places of Stars," we find the two bright stars whose right ascension are nearest this time are α Persei and α Tauri (Aldebaran), the former having right ascension

$3^h\ 18^m\ 38^s$, Decl. 49° 34.8′ N.,
the latter $4\ 31\ 22$, 16 20.9 N.

Corrected altitudes of each and time of sights were

(1) α Persei 34° 36.8′, G. M. T. $0^h\ 2^m\ 54^s$
(2) α Tauri 67 18.4, G. M. T. 0 4 00

For First Sight, α Persei.

	h	m	s
L. S. T. at noon G. M. T.	3	57	06
G. M. T. of observation	0	2	54
L. S. T. of observation	4	00	00
R. A. of α Persei	3	18	38
t of α Persei	0	41	22

Second Sight, α Tauri.

L. S. T. at noon G. M. T.	3	57	06
G. M. T. of observation	0	4	00
L. S. T. of observation	4	01	06
R. A. of α Tauri	4	31	22
t of α Tauri	0	30	16

First Sight. On lower scale: Lat. 5° S. and Decl. 49.6° N. gives

$$A = 38.4$$

Straight-edge through 38.4 and 41.4 gives $R=45.0$.

Obs. alt.	34°	36.8′	
R		45.0	
Merid. alt.	35	21.8	
	90	00.0	
Z	54	38.2	S.
d	49	34.8	N.
L	5	03.4	S. (True L is 5° 04′ for data given)

Second Sight. On lower scale: Lat. 5° S. and Decl. 16.3° N. gives

$$A=11.7.$$

Since t is over 30 and A less than 12 this sight cannot be worked by this method.

Hammond V. Hayes Laboratory, Boston.

[COPYRIGHTED]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

REBUILDING THE NAVY'S ENLISTED PERSONNEL

By LIEUTENANT E. R. HENNING, U. S. Navy

In a problem of this nature no time need be lost in the presentation of the lamentable details of the unsatisfactory condition of the naval personnel, both as to numbers and as to quality. Such details are common knowledge.

The situation is hazardous. It is costly.

For lack of trained men, dependence placed on recruits bears fruit in the tribute inexperience exacts—damage. And damage to ships, to machinery, is costly.

It will not be questioned that there must be a strong proportion of trained men in the battle fleet to maintain proper readiness for war. Nor will it be questioned that the proportion cannot drop below 50 per cent of the allowed enlisted complement without loss of efficiency. A gun deck, a fire and engine room, filled with recruits makes a battleship a training ship, with consequent low readiness for battle value. It may be regretted, but the days of the old frigates are past, the days when a captain could ship a green crew with a seasoning of old hands in June, and by October have a smart ship's company. To-day the activities aboard ship are more diverse than setting and furling sail, and running the smoothbores in and out.

It is not so much the question of enlisting men as re-enlisting them. Such resorts as the two-year enlistment defeat their own ends. The two-year man lacks interest—possibly because he knows his time in the navy is only brief. The expiration of his enlistment arrives at a bad time. At the end of four years most good men are rated or about to be. At the expiration of two years, however, it is the exceptional man, in peace times, who is a petty officer. The two-year man has been in long enough to feel all the disadvantages of the service, but not long enough to appreciate the

advantages. It is the low point of the morale curve. So out he goes when he is just arriving at a point where he is of value to the navy. The trouble and expense of his training are lost. The process begins over again with the recruit who takes his place. Initially, the two-year enlistments may gain more men, but in the long run the four-year enlistments should show a gain, not only in the quality and training of the men, but in their numbers.

The argument may be advanced that the short enlistment plan builds up a reserve. Granted, but of first importance is a sufficient active force. The navy cannot operate on its inactive reserve.

The problem is to keep men in the service, the skilled trained men. In private industry the employment problem has been met by an unprecedented increase in wages. Advance of service pay will not alone solve the personnel question for the navy. Service pay under the most favorable conditions will never approach that paid to men of corresponding ability in civilian life. Other inducements to remain in the service must be offered.

Why doesn't the bluejacket re-enlist? Evidently life holds more for him on the outside. His brother Bill writes him from Detroit where he is working in an automobile factory; writes about the car and his wife and the fur coat he bought her last week. Your machinist's mate or electrician ponders that letter and some invidious comparisons arise in his mind. Why shouldn't he get out and emulate or exceed Bill's success? They always considered him a more clever chap than Bill anyhow. What has he now? Three meals a day and a hammock. As for the girl back there in New Haven, he has a big chance, hasn't he?

So out goes your capable petty officer, and you struggle with a boy to take his place who has been in the navy four months.

There is another phase of the loss of trained men. The following is quoted from the Bureau of Navigation's letter of April 19, 1920:

> Requests for discharge for dependency are now being received at the average rate of 28 per day. An average of seven such requests are approved each day. With few exceptions, *the men making such requests are the older experienced men.* This produces a loss of about 200 trained men per month.

These men want to get out before their enlistments expire. A far greater number stick to the end of their enlistments, but for the same reason of dependency don't re-enlist.

It is a valid reason for men to wish to leave the service. Men of the petty officer class should be able to support a wife or dependent parent while in the navy as well as if they were working in a factory or office. Most men on reaching their twenties have dependents or responsibilities. Shall we exclude this class from the navy? Then, of course, we must be content with the boys we are enlisting at present, and content with losing them when they become men. Again quoting the Bureau of Navigation's letter:

> . . . . It may therefore be stated that two-thirds of the present first enlistments are under 20 years of age. The remaining one-third do not average much above 20 years of age. . . . . Account must further be taken of the fact that the losses given in paragraph 7 (trained men) are steadily reducing the number of men *who can keep the wheels turning, and can assist in developing new men.*

There is an evil result following the refusal of these men to re-enlist. It is the demoralizing effect on the recruiting campaign. No amount of advertisement or other recruiting efforts are going to counteract the insidious effect of a mass of often disgruntled and dissatisfied men going out of the service. Conversely, the example of a large body of men contented and satisfied to remain in the navy would gain more recruits than the most elaborate recruiting campaign. A satisfied man is a splendid advertizer.

A story in a recent periodical illustrates the point.

A recruiting sergeant observed a young man outside the office gazing interestedly at the posters.

"Thinking of enlisting, my boy?" he inquired. "Fine life, good pay, education, travel, etc."

"I dunno," replied the youth. "I'll come back next week and see you."

"Better make up your mind now," urged the sergeant, "because I am getting out to-morrow."

What is the *bête-noire* of the seafaring life? Isn't it the little opportunity that exists for having a permanent home and enjoying the pleasures of one's fireside? These are elemental desires that at some time possess every man, be he a humble seaman or a choleric old bachelor officer. Herein can be found the solution of the personnel question; something to offer the trained men; a boon that will put a premium on efficient service.

To this end homeport the ships; make the homeport not a figure of speech as far as the personnel is concerned, but an

actuality. Make the homeports bases from which the ships operate; places from which the ships go out for their exercises and drills, and where they return; a week or two at sea followed by a week in port—the homeport.

There the men could establish their families. When off on cruises they could look forward with assurance to seeing their wives and families; to enjoying the relaxation of home after hard work at sea.

Yet another step is needed, a more radical step. It would improve the lot of the enlisted men little to simply homeport the ships. Even with the present increase in pay, the men in the service cannot meet the extortionate demands of the landlords, inevitable at any place where the navy may be in force. Many officers, nowadays, must smother their pride and live in quarters little above squalid. What chance is there, then, for the enlisted men?

That situation can be met too. At the homeports build modest quarters available for all petty officers who have wives or other dependents in their immediate families.

That, briefly, is the plan.

Keeping in spirit with the idea, there are some changes in the peace routine of the fleet necessary. The winter period at Guantanamo might with profit be reduced to a few weeks for the actual firing of target practice, if the admittedly ideal weather conditions are held indispensable. Many officers and men grow restive spending a fourth of each year off the sun-baked barrens of southern Cuba. Instead, a six weeks' cruise every year to Europe or South American waters would be found to have a tonic effect on the morale of all hands.

To the strenuous objectors to changing the long established routine of the fleet much might be said about certain disadvantages of a warm-weather fleet reorganized once or twice a year, and drilled up to a maximum of efficiency, followed by a period of relapse, and shifting or loss of a considerable part of the drilled crews. Certain factors of superiority might be pointed out in a fleet manned by a more permanent personnel whose efficiency was maintained at an even level—a fleet used to operating under the varying conditions met throughout the year in the North Atlantic. Permanent operating bases would overcome the idea that the Guantanamo period is the real worktime of the fleet, and that the

time in northern waters is a time of let up and turn over of personnel. The suggested plan would make an all the year around fleet.

For the Pacific fleet, the adoption of the plan would compel less change in the operating routine than for the Atlantic fleet.

The cost would not be prohibitive. Millions have been spent by industrial concerns in executing housing and other schemes for the contentment of their employees. When consideration is given to the saving in upkeep and economic operation with skilled trained crews, and the cutting down of machinery accidents so frequent with recruits, no stretch of the imagination is required to see an actual gain in the dollars and cents operating cost of the navy.

What places are most available for these bases for the personnel? On the east coast there are such places as Newport, Yorktown, and Hampton Roads; on the west coast San Francisco, San Pedro, and San Diego.

No doubt this plan will inspire some very valid objections, but it will get and hold good men—the paramount consideration in the navy at present.

On the other hand, there will be those who will throw up their hands in horror and ask what the navy is coming to; those to whom it is inherent to object to any change in traditional policy; the class who will never remember that the days of the men who manned the old square riggers have passed—the days when men would ship for 15- or 20-month cruises, men to whom it was all in a day's work to tear the nails off their hands furling ice-coated sails in a North Atlantic gale, cursed at from below by a bucko mate with a ready fist or belaying pin. Watch on deck and watch below, and a staple diet perhaps of salt horse and biscuits; this it was for a few dollars a month and a drunken carousal ashore after a cruise.

Of course, the day of that kind of American has long since passed. The man who follows the sea expects as much out of life as the worker ashore.

There will always be a considerable minority who will want cruising duty, particularly the young recruit. For them, duty should be open on the cruising ships, the ships on foreign stations.

I may digress here to say there are certain advantages in sending recruits to the smaller ships on detached duty. Most officers

will concur that there is more opportunity for the newly enlisted man to learn the elementary things on a gunboat or small cruiser than there is on a battleship. In the small ship's company, each man is more nearly under the direct supervision of his officers; more time can be devoted to his individual instruction; his duties are more diverse. He becomes an all around sailorman. On the other hand, the recruit on the battleship is an unnoticed unit in a thousand men. The handling-room crew, a life-buoy watch at sea, and a certain allotted space of paint work to scrub—that may be his duty for months.

The best sailormen I have ever seen were on a navy oil tanker. Nearly all recruits, when the ship went in commission, in a few months all but a few could steer, heave the lead, keep a sharp intelligent lookout, and knew how to handle a rifle. They could get away a lifeboat smartly, and put their backs to the oars, without that ludicrous exhibition that a boat's crew from a battleship so often present. The snap and expertness they attained in handling the 4-inch guns I have seldom found equaled by the broadside crews of a battleship.

There follows another advantage of the suggested plan. About the time the new man tires of strange scenes and movement, and wants to stay in one place for a while, he knows he has the chance sooner or later of going to one of the ships with a homeport. The prize of quarters puts a premium on obtaining a rating. It creates an incentive for hard work and good conduct.

Thus, the fleets with their homeports should have the highest percentage of trained men. Valuable time for advanced work need not be taken up in elementary drills for recruits.

The bluejacket could see a future before him, the chance for a home and a family the same as the fellow on the outside. Many men that we are now losing would re-enlist with the adoption of this plan; many who are now out would rejoin the service. The personnel would be stabilized. The married man is less prone to change than the bachelor. Contentment, and *esprit de corps*, lacking in the navy now, could well be expected with this plan.

Upon the submarine to which I am attached, the quartermaster is leaving the navy in August because he has a wife in the States whom he has not seen for months, and whom he can't afford to bring down to the Canal Zone and support there, at the high cost of quarters in Colon. He extended his enlistment a year

when he was enabled to transfer to a submarine basing on the Canal Zone because he heard that "there were quarters for married men there." Disillusioned, of course, he is getting out.

Again, there is an electrician first-class—the only enlisted man aboard the boat, other than the chief electrician, who can be depended upon for electrical work; discounting two short enlistment recruits "striking" for electrician who show little energy or interest in qualifying for a rating. This capable electrician, however, leaves the service in a month. He is going to get married. Splendid material, with two years of engineering at Lehigh behind him, likes the navy immensely, he would re-enlist were there quarters for married petty officers on the submarine base. The recruits will have to do his work.

I make bold to say that the navy has never gone at its personnel problem with the soundness of policy of big business. Probably, because with the latter it is solely a matter of dollars and cents, unhampered by any traditional point of view. Efficient industry has scrutinized all its activities; the success of a process is its justification. What does not pay is cut out with a ruthless hand.

The point of view in the navy must undergo that orientation so that the handling of the personnel is such as will get and hold the men who will fight the ships the best—whether the method counters tradition or not.

Disregarding a century of traditional tactics, Nelson broke through the Line Ahead formation at Trafalgar. If we break through the "line ahead" in the traditional handling of personnel, we may attain as startling a success.

Finally, if this plan will not keep the ship's companies filled with the right kind of men and enough of them, outside of an increase in pay far in excess of that recently granted—what can be offered the enlisted personnel?

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

FUNCTIONS OF THE OFFICE OF NAVAL OPERATIONS

By COMMANDER R. CASTEX, French Navy

Translated by PROF. ALLAN WESTCOTT, U. S. Naval Academy

I have recently read with keen interest the excellent article by Commander A. F. Carter, in the U. S. NAVAL INSTITUTE PROCEEDINGS for February, 1920, on *The Functions of the Office of Naval Operations*. This question presents itself in every country, and as it is of capital importance, I should like to set forth certain general considerations on the subject, which it may be useful to correlate with those expressed by Commander Carter.

For greater simplicity, I shall refer in these considerations to the institution that controls naval operations in France, that is, the general staff—*état-major général* (E. M. G.).

The evolution of ideas regarding the general staff, which has manifested itself recently in the French Navy after the remarkable example set by the army, has led to the recognition of two fundamental principles for the organization of the general staff:

1. Absolute separation between the *general staff*, entrusted with the objective preparation for war, and the various administrative bureaus, entrusted with the subjective realization of the plans of the general staff, and each concerned with a single phase of naval activity or a single corps (personnel, yards and docks, health, naval construction, ordnance, etc.).

2. The internal organization of the general staff in three bureaus, as in the army, these bureaus permitting the general staff to accomplish the three parts of its objective task, which is, in the current phrase, *savoir, vouloir, pouvoir*, which may be freely translated, to understand, to decide, and to provide means for the execution. The three bureaus are as follows:

First bureau—Organization (pouvoir).

Second bureau—Information (savoir).

Third bureau—Operations (vouloir).

The office of naval operations, as understood by Commander Carter, is thus, in France, the third bureau of the general staff. It is to this bureau that the following study refers, but it may also be applied to any organization for a similar purpose.

I may add at this point that what I am about to say of the functions of the third bureau represents purely personal conceptions, and need not be considered in any sense as official doctrine.

The theoretical functions of the third bureau of the general staff may be grouped as follows, combining those of peace-time and those of war-time:

A. *Operations.*—Preparation and execution of operations. Plans of operations. Orders and instructions for operations.

Operations of surface forces, patrol forces, aerial forces, submarine forces, merchant marine. Protection of commerce and fishing craft.

Operations of coast attack and coast defense. Liaison with land forces.

Landing operations.

Record of naval operations. Record of losses.

B. *Movements.*—Fleet movements. Distribution of forces. Current ship movements.

C. *Instruction and Training.*—Preparation of personnel for war. Exercises. Maneuvers. Courses for training schools.

Strategical and tactical studies. Practical problems. Military ideas. Doctrine.

D. *Liaisons.*—Missions abroad. Sending and receiving of liaison officers.

Personnel of Bureau.—For a large navy, it would seem that these functions, in time of peace, could be carried out by a force of eight officers, in addition to the bureau chief,—*i. e.*, four for operations, two for movements, and two for training. The liaison service would be constituted only in time of war, and on this account the force required would differ in war and in peace. In war time four officers at least should be provided for liaison.

The chief of general staff would presumably keep in constant touch with the third bureau, in view of the importance of its work. One of the two sub-chiefs would be permanently at the head of this bureau and the second.

Plans of Operation.—The preparation of plans of operations is the essential and fundamental rôle of the third bureau. It would prepare them both in time of war and in time of peace. The only difference between the two situations would be that, in the second case, it would have more time and more freedom of mind than in the first. The *plan of operations* is a document of capital importance. It expresses the general purpose, the very end and reason for being of the navy. It is the basis of everything. It is the skeleton of the organization. Into it should articulate and from it should branch out all personnel, material, industrial, and financial provisions. Even if it is not always easy to realize them—since they may call for means that are lacking—the plan of operations should at least clearly set forth the objectives to be attained.

The plan of operations is above all objective. It proposes to operate against someone, against something, in a word, against an enemy. It is thus completely guided by the political conditions of the moment. As has sometime been said, "One does not prepare for *war*, one prepares for *a war*."

We need not concern ourselves here with the fundamental qualities which a plan of operations should possess; that is, with the strategical properties which it should combine. We have in view only its form.

On this latter point, Von der Goltz has written, in *A Nation Armed*, a passage which gives an idea of the subject and may serve as a guide. He says:

> The plan of operations should be presented in the form of a memoir which begins with considerations on the political and military situation, and a comparison of the forces opposed, and decides therefrom the general line of conduct and the choice between the offensive and the defensive.
>
> The memoir should next set forth what the adversary can do and where he will effect the strategical deployment of his forces. It will explain where we shall deploy ours and how they shall be grouped. It will determine the choice of directions for our first movements, the aim of which is to bring about a decisive battle. . . . .
>
> Here the offensive plan and the defensive plan separate. The first goes on, indicating the general purpose to pursue until the adversary is forced to conclude peace. The defensive plan stops at the turning point which permits assumption of the offensive.

These words in effect summarize what a plan of operations should contain, and constitute a useful outline, provided it is given

a little order and the subjects touched on are classified according to their nature.

In my opinion, the plan of operations, being objective, belongs to the category of orders or instructions which have to be prepared with a view to operations. There is indeed only advantage to be gained by putting it in the well-known form and subdividing it into three main divisions in the order "situation, mission, execution." Such a division of material will add clearness and will oblige those preparing it to follow a logical sequence, consisting, as customary in orders for operations, of first stating the problem and then supplying the solution.

The part relating to "situation" has here a particular importance and character, in view of the size of the question treated and the intervention of factors connected.

"The plan of operations is only one part of the plan of war," and this is seen when its preparation is undertaken. It is then evident that the plan must take account of an infinity of considerations not apparent on first examination. It must take account, first, of plans for land operations, and if these seem of primary importance for success in the war, the plan of naval operations must be modified to supply the aid which it ought to render. Everything relating to external politics should be carefully envisaged, with the same object in view. The same also with economic elements in the conflict, and if possible with the financial conditions. No less care should be taken to grasp the elements which sustain the morale of the warring nations. The plan of naval operations is thus in close relation with other plans, its fellows, which constitute with it the plan of war,—the army plan, diplomatic plan, economic plan, financial plan, morale plan, etc.

It follows therefore that the part relating to "situation" in the naval plan should have corresponding subdivisions, *i. e.*,

1. Enemy naval situation.
2. Naval personnel situation.
3. Military situation on land.
4. Diplomatic situation.
5. Economic situation.
6. Financial situation.
7. Morale situation.

And every other "situation" which it appears necessary to envisage.[1]

The enemy naval situation calls for close examination of the adversary's material, resources, ships available of all types, aircraft, etc. . . . . ; his faculties of mobilization (numbers, period required for the operation, etc.); his possible time and points of concentration; the operations he may plan; the support he will be able to draw from his bases; his coast defenses; the training and worth of his personnel; his strategical and tactical policies; the character and military ideas of his leaders, etc. This makes an important document, in which are gathered up the patient labors of the second bureau in time of peace.

The same labors will be utilized for our own forces, to supply a concise account of the means at our disposal, the places and stages of their concentration, and the sources of supplies that may be utilized. Our secondary characteristics (training, morale, etc.) should likewise be studied. All this gives us the "naval personnel situation," the greater part of which is based on information supplied by the first bureau. This part will not treat of operations, which belong to the "Mission."[2]

The military situation on land will be given very serious consideration. In its main outlines at least, the plan of operations of the armies should be understood, in order to provide for support by the navy, or inversely, according to the objective which it appears most urgent to attain. If a combined operation is contemplated, the study will not be limited to this general survey, but will naturally go into details. This implies, in time of peace, an intimate contact between the third bureaus of the army and navy general staffs.

The diplomatic situation will be summarized similarly in cooperation with the Minister of Foreign Affairs.

The economic situation, situation relating to morale, etc., will be examined in the same way.

Finally it is essential not to lose sight of the geographical situation. It will supply material for study regarding the presumable

[1] For an example of such a study see Lt. Col. Nordacq, Étude d'une situation strategique, *Revue militaire generale*, March, 1913.

[2] The naval personnel situation should include that of allies, if such there be.

theatre of future operations, and will call for all information available concerning routes, distances, strategic points, anchorages, hydrography, climate, marine and aerial conditions, facilities for blockade, etc.[3]

Map sketches will aid in this study. The aim should be to establish not only this "geographical situation," but also the desiderata relative to organization of the theatre of operations (permanent or temporary bases, supplies, communications, etc.) which belong in the part "execution."

To summarize, the part dealing with "situation" should, it appears to me, be composed of a certain number of separate statements dealing with divers particular situations, acompanied by a résumé of the whole defining the general situation.

The division "mission" will study the different possible solutions of the military problem, based on what is known of the situation, the enemy's possible efforts, and what we are able to do ourselves. It will determine the operations possible and desirable, both principal and secondary (transport, commerce warfare, coast attack, blockade, etc.). It will evidently be necessary in this research to examine a considerable number of hypotheses, and to survey various means of attaining the same result. Such thoroughgoing discussion is possible here, for the plan of operations is neither orders nor even instructions, but simply a forecast, a preliminary investigation, which is not intended for subordinates, and which serves only to clarify the ideas of the composers. This will permit the elaborateness of a comparative study. Nevertheless, the conclusions should be as decisive and definite, in regard to operations to be undertaken, as if it were an order.[4]

The division "execution" will lay down the measures necessary for the realization of the operations contemplated. It will determine the forces to assemble, the place and time of their assembly; it will calculate the forces to be provided beforehand in time of peace, and the required measures of mobilization, both for the active service and the reserve. This work will cover all types

[3] Types of studies of geographical situation: (1) Mahan, *The Problem of Asia*, study of the North Pacific (p. 31), study of the Caribbean (ch. VIII). (2) *Revue Maritime*, 1911, Vol. 188, study of the North Sea Theater of Operations (German article).

[4] This discussion of *mission* implies liaison and understanding with land forces and with allies.

of forces—surface, submarine, aerial, patrol (requisitioned ships), merchant marine, coast defense, etc., commencing with the most important and continuing down. It will end with logistical prescriptions, regarding permanent and temporary bases, train, convoys, etc. All this division "execution," when finished, will be communicated to the first bureau, which will fix definitely, entering into greater detail, the organization, constitution, and distribution of forces and material. The first bureau will communicate this information in turn to the various branches of the service, which will base their own plans thereon. Such is the theoretical method of establishing a plan of operations, with its appendices.[5]

All the work thus far outlined is within the general staff office. To bring the plan to the attention of those concerned, secret instructions will be sent out, based on the plan and designed to provide for its execution. Certain of these instructions will deal with measures to be taken in time of peace; others with measures in time of diplomatic tension and mobilization; still others with operations properly so called.

The plan of operations thus established is not fixed beyond all change. It develops constantly, even in time of peace, according to developments in the *situation*, and especially in the political situation. It will therefore be more or less frequently revised and brought up to date.

Besides, this plan is not supposed to foresee the entire unfolding of a war. It is limited to the initial phase, and the best presentation of forces. In the course of hostilities, as the situation changes, it will be necessary to study anew, produce other plans, and issue other instructions.[6] That is what the phrase "conducting war" means.

Journal of Operations.—It is desirable that the third bureau in time of war should keep the log or journal of naval operations. All facts of interest will be there recorded, and mention made of

[5] This sketch of a *plan of operations* will also serve as a preliminary study for *orders* for particularly important operations, from whatever general staff they may emanate.

[6] With this in view, the third bureau will in time of war maintain the same relations as in time of peace with the first and second bureaus, the direction of land operations, the government, the foreign office, other ministers concerned, and the forces of allies.

orders and instructions for operations, to be found in full elsewhere.

Losses in personnel and matériel, and in particular losses of naval and merchant vessels, will be appended to the journal.

Movements.—The movements of the fleet have always properly been regarded as essentially under the cognizance of the general staff. Every movement in fact involves the idea of management, of utilization of forces, which is the business only of the general staff.

Within the general staff office, movements should be allotted to the third bureau. They are in fact closely linked with operations, since every change in the geographical distribution of units affects previously made plans, and inversely, these plans may require certain changes in the movements, as measures of either execution or preparation. It is therefore logical that the third bureau of the general staff, having charge of the plans of operations, should know how its units are distributed and consequently have cognizance of movements.

It is desirable, moreover, to take the word "movements" in its broadest sense. It should apply to all operations of putting ships into or out of commission, or into reserve, condemnation, division and grouping of naval forces both active and reserve, classification of ships as to readiness for service, etc. In this respect also, the third bureau should thus be in close contact with the first bureau. The latter will give to the third bureau all the required information regarding the forces and resources available.

Instruction and Training.—The proper instruction of personnel for war is achieved only by a series of incessant efforts and intensive training in time of peace, beginning with elementary exercises and terminating with fleet maneuvers. It is evident that the general staff should supervise and prescribe the ordinary execution of these exercises, for it alone knows to what ends the efforts of all should be directed. It is as responsible in this respect as in matters of matériel.

This function goes logically to the third bureau, belonging properly, like movements, to those external activities coming under the head of operations. This bureau will therefore concern itself with the training of the various arms of the service,—gunnery, torpedo, submarine, aeronautics, etc.,—and with the exercises by which it is accomplished. It will extend its cognizance to grand

maneuvers intended to bring these arms into harmonious cooperation, and to throw light on important questions of strategy and tactics. To this end it will give the necessary directions, and examine and criticize the results.

But while playing this rôle of guide and supervisor of training, as regards general doctrine and aims, it can work only to the advantage of the third bureau of the general staff to delegate to the various branches of the service the details of such training, when circumstances permit. It is fitting enough, for example, that the office in control of ordnance, including as it does naval officers, should establish regulations for target practice, or that the office in control of submarines should issue instructions for torpedoes or submarine training, after having consulted the third bureau as regards the main outlines of these documents. The same is true of aeronautics. This would permit the general staff, while accomplishing what is expected of it, to avoid becoming overloaded with details. It would limit itself to giving general suggestions to the service, and supervising the plans of the latter before they take definitive form.

The preparation of personnel, before it is carried out in active service, begins however in the various special schools. The third bureau will have therefore, not the actual direction of these schools, but supervision over the instruction given. If only for the sake of knowing what it may expect of each branch of the service, it will consequently set the requirements for admission and the course of instruction in all institutions engaged in training for the navy, whether for line or staff, for officers or enlisted men, or for whatever specialty.

Doctrine. Studies and Military Principles. Directional and Educational Rôle of General Staff.—In a higher degree, for officers, preparation should mean not only professional and technical knowledge of matériel, but a grounding in important military principles and matters of war.

It is superfluous to call attention here to the necessity of community of thought among the members of a military force destined to fight together. This alone will assure, in time of peace and during hostilities, convergence of effort and continuity of policy in command. This is what is called " unity of doctrine," even though this phrase has sometimes been distorted and taken to mean the establishment of such a synchronism that every officer will auto-

matically see a given situation from the same angle. Such enslavement to doctrine is unnecessary, for it would mean killing initiative. "In spite of unity of doctrine, a given situation will as a rule suggest more or less divergent solutions as a result of individual temperament and type of mind. Unity of doctrine is powerless, indeed, to bring about that a situation, an event, shall produce the identical reaction in all. But it prevents anarchy of ideas, and for this reason it is of inestimable value."[7] The essential thing therefore, in matters of higher military training, is to avoid fundamental divergences in individual conceptions.

This doctrine, since a doctrine it is, is especially necessary in the navy, for this environment, more than any other, seems completely ruled by perfectioning of matériel, by scientific discoveries, and by the appearance from time to time of new instruments which give rise often to misguided ideas. In the employment of these instruments there is a danger to be guarded against of frequent disturbance of mind and of crises during which the general state of mind and military ideas oscillate seriously.[8] This should be remedied by doctrine. Its beneficent effect, moreover, is not limited to military action in the narrower sense; it extends also to matériel and its characteristics. Often after long periods of peace, with no proof from practical experience, there are genuine difficulties in this respect. Improvements in the mechanical sphere seem completely revolutionary; sensational achievements of foreign navies create an unreflecting desire to copy them slavishly; public opinion is concentrated on machines the practical value of which is unknown. It is then, in this general confusion, that a firm doctrine may render real service. It is moreover implicitly necessitated by the fact that it is the combatant personnel who must primarily decide what qualities are to be called for in matters of matériel.

In all these moments of perplexity, we await a voice from above to set the course anew, define the policy to be pursued, and orient the service in the new conception. We feel that we cannot without peril allow anarchy, as so often in the past, to dominate our military ideas.

Now this guidance can come only from the institution responsible for the war training of personnel, that is, from the general

[7] General Bonnal.

[8] Example: The uneasiness of mind after the World War, brought about by the outstanding facts of submarine and aircraft development.

staff. This function, in its full sense, includes also the task of filling the minds of the service with the same ideal, of spreading abroad the same ideas on the conduct of war, the training of men, and the mastery of matériel. It is essential that the general staff should take account from time to time of the intellectual needs of the officers, of their uncertainties also, to let them know that a superior control has considered the problem which occupies them and its solution. This is one of the highest rôles of the general staff, and a rôle which it alone is able to fill.

Marshal Foch once summarized the double function in this respect of the army chief of general staff:

> Not only to take care of the army in a material way, assuring its concentration for mobilization, but also to prepare and instruct it for the requirements of modern war, and to develop in particular, in a general staff corps trained by him in his doctrine, the unity of opinion alone capable of assuring convergence of all efforts in execution.

This intellectual guidance in the preparation of personnel enters into the attributions of the third bureau. The chief of general staff will naturally take up the matter most closely. In accordance with his suggestions, the third bureau will undertake the action necessary to attain a rational military doctrine, based both on past experience and upon what logical deduction is able to forecast for the future; above all it must be adapted constantly to the continuous changes in weapons and machines.

The third bureau will keep informed of what is said or written, at home and abroad, in military matters, in order to discuss and assimilate or reject it as the case may be. If the need arises, it will take the initiative in studies of this character, carrying them out itself or confiding them to other officers, who will work in accordance with its directions. It will draw up a report and a *critique* of naval maneuvers, and it will extract from these exercises whatever it considers useful for the intellectual guidance of the whole combatant corps. Likewise, every war will call for a work of the same kind, so far as information available permits, accompanied by deductions and comments. Moreover, aside from such circumstances, if cases arise where, in the presence of general uncertainty or numerous individual divergencies, it is necessary to take the lead and rally all minds to one opinion which it considers sound, the third bureau will accomplish this by expressing its views by means of circular notes summarizing a point of doctrine,

and going out officially to all officers. Other occasions for similar action will often occur in connection with the dissemination of despatches or official circulars dealing with service matters; they will afford means of incidentally calling to mind essential military principles and thus diffusing the views of the body in control. These will supplement the other procedures.

It will do no harm, moreover, if the third bureau extends its educational rôle beyond the navy, and exercises it especially upon public and parliamentary opinion, to win them over to its ideas and thus facilitate their realization, which, in every country with a democratic government, depends upon these two factors. This also is quite in the spirit of preparation for war. The general staff should concern itself with the state of opinion in regard to naval problems, and lead the struggle for the view it believes right. Advantage will be gained by suggesting or even preparing press articles defending its theories and forcing their consideration and also by authorizing some of its members to give lectures expounding[*] official views, thus getting in touch with the associations which lead public opinion in naval matters.

A similar policy should be pursued by the third bureau in respect to members of parliament. It should supply them frequently with information and also, after the excellent custom of the British admiralty, address them periodically in memoirs which explain its views and its considered policies. It should as often as possible invite the naval committees of the two houses to visit naval bases and even attend naval maneuvers.

Similarly the general staff, by the intermediary of the third bureau, should exercise control over the institution for instruction in strategy and tactics, that is, the naval war college, which will at the same time constitute a supplementary source of information for the staff. This leads me to insist on the necessity of close unity of thought between the general staff and the war college. These two institutions should intimately collaborate. Both will derive sure benefit. The general staff will thus be able to impress its ideas upon the officers who will later occupy all the posts of the general staff. Inversely, the general staff will have available in the war college a kind of studies section,

[*] The general staff of the German army established in 1903 a quarterly review intended to voice its opinions.

unpreoccupied by routine duties, where one may meditate at leisure on the problems of the hour. These may be set for solution there, and much of the work of the college, especially its map work, will contribute usefully to the clearing up of doubtful points on which the general staff will be glad to have advice. This link between general staff and war college, where such exists, is moreover the rule in many navies.[10] Aside from the personal action of the chief of general staff, and the control exercised by him over the entrance examinations and courses of instruction, this union may be assured by assigning several important courses to officers of the general staff.

Strategic Liaisons.—This part of its duties will in time of war form a large part of the activities of the third bureau of the general staff. It will thus centralize the service of outside missions. It will send out liaison officers to subordinate units, to fleets, naval districts, bases, etc. . . . . It will cooperate also, the case occurring, with the allied naval forces and higher commands, or even with land forces, if the situation requires. Reciprocally, the third bureau will have the duty of receiving the liaison officers sent from these sources. It will put them in touch with the subchief and the chief of the general staff. Then, their report made, these officers will be re-attached to the third bureau and work with it during their sojourn with the general staff, before leaving to rejoin their units.

They will thus have lived for some time in the environment of the central control, breathing its atmosphere, absorbing its ideas, and thus accomplishing what is expected of liaison officers.

[10] Before the war of 1914, the Naval War College at Portsmouth worked in liaison with what was then the British General Staff (Intelligence Department). In the United States, the Naval War College at Newport was considered as an adjunct of the Office of Naval Intelligence (American General Staff). In Germany, officers leaving the college nearly always were detailed to the *Admiralstab*.

DISCUSSION

What is the Matter with Operating Engineering?

(See Page 1431, Whole No. 211)

Lieut. Commander R. R. Smith, U. S. Navy.—The article in the September number by Lieut. Commander H. F. D. Davis, U. S. Navy, inquiring as to "What is the Matter with Operating Engineering?" covers a subject which is becoming of increasing importance. This is particularly so in view of the tremendous increase in the number of new vessels, the engineering plants of which vary widely in type and design from each other, chiefly as a result of the development of turbine engineering. As long as the reciprocating engine was the standard type of marine propulsion and the chief difference between ships was that of size, operating practices were well standardized and repairs and casualties were covered by well established practices. With the advent of turbines, and the steady improvements in their design and combinations both by the manufacturers and the Bureau of Engineering, a similar change was introduced in engine room auxiliaries involving radical departures from previous types.

The engineer who keeps abreast of these changes finds that the knowledge acquired yesterday no longer holds to-day; that the turbine even before its complete development is being supplemented in capital ships by electric drive. It is not surprising, then, that the older engineer finds much of his knowledge insufficient and that the new engineer operates the plant at his disposal more with a view to safety than economy. The situation is further aggravated by the outpouring of new ships, built at great cost, for which supervising and engineering personnel is not available.

It is hard to concur in the statement in the commanding officer's letter, that "there has never been more competent commissioned engineering talent in the battleship force than is the case to-day." However, it may be so for the force in question but the same cannot be said for the service at large.

A comparison has been made between gunnery and engineering performance. Gunnery has been developed from the stimulus it has received from the seagoing personnel, whereas the development of engineering has taken place chiefly from shore. The gunnery officer serves a longer apprenticeship at his work and is, therefore, more conversant with the details of the ordnance equipment of his ship. His time is not wholly occupied with the upkeep of the matériel and he has a greater opportunity to devote his time to the development and training of the personnel and to work out and develop new ideas in connection with personnel, matériel and methods.

The average engineer officer enjoys the title of his office because he has been so detailed and not because he has been trained as such. His responsibilities are such as to keep him fully occupied in the upkeep and successful operation of the plant while the personnel duties which are performed by the executive officer for the deck force are discharged by the engineer officer for his force. Without special training he is dependent upon his subordinates for the really important mechanical decisions, and never reaches the point where his work becomes constructive rather than routine. He leaves the development and improvement of engineering matériel to the Bureau of Engineering. I am speaking of the average engineer officer; there are, of course, many exceptions.

Does the engineer officer of a ship regard his work as a preparatory step to higher command as does the navigator, the executive or the gunnery officer? He does not, and he also realizes that he must not be too closely identified with engineering duty for too great a length of time lest it work to his detriment. When an officer is assigned to engineering duty only he is in the happy position of being able to devote himself unreservedly to engineering. The officer who prefers engineering work but whose application for engineering only is declined must turn to something else under present conditions.

The answer to the question "What is the Matter with Operating Engineering?" is, "There are not enough operating engineers of proper experience to handle the engineering plants of the ships of the navy." If we are to interest officers to become skilled engineers we must hold out some inducements to them—a condition which does not exist at present. What is sadly needed is a policy on this subject. Until a definite policy is established with relation to the operating engineering personnel which will foster interest in engineering and place it on the same honored plane as gunnery, we will have to be content with present conditions.

U. S. NAVAL INSTITUTE

SECRETARY'S NOTES

Membership Life, regular and associate, 5335. New members, 39. Deaths (2):

Captain H. M. Dombaugh, U. S. N.
Commander W. J. Terhune, U. S. N.

Dues The annual dues ($3.00) for the year 1920 are now payable.

Regular and associate members of the U. S. Naval Institute are subjected to the payment of the annual dues until the date of the receipt of their resignation.

Discussions Discussion of articles published in the PROCEEDINGS is cordially invited. Discussions accepted for publication are paid at one-half the rate for original articles, or about $2.25 a page.

Address of Members *All members are urged to keep the Secretary and Treasurer informed of the address to which* PROCEEDINGS *are to be sent, and thus insure their receipt.* Members and subscribers are urged to notify the Secretary and Treasurer promptly of the non-receipt of PROCEEDINGS, in order that tracers may be started. The issue is completed by the 15th of each month.

Book Department The Institute Book Department will supply any obtainable book, of any kind, at retail price, postage prepaid. The trouble saved the purchaser through having one source of supply for all books, should be considered. The cost will not be greater and sometimes less than when obtained from dealers.

Reprints of Articles

The attention of authors of articles is called to the fact that the cost to them of reprints other than the usual number furnished, can be greatly reduced if the reprints are struck off while the article is in press. They are requested to notify the Secretary and Treasurer of the number of reprints desired when the article is submitted. Twenty copies of reprints are furnished authors free of charge.

Illustrations

Authors of articles submitted are urged to furnish with their manuscript any illustrations they may have in their possession for such articles. The Institute will gladly co-operate in obtaining such illustrations as may be suggested by authors.

Original photographs of objects and events which may be of interest to our readers are also desired, and members who have opportunities to obtain such photographs are requested to secure them for the Institute.

Notice

Whole Nos. 6, 7, 10, 13, 14, 15, 17, 144, 145, 146, 147, 149, 155, 167 and 173 of the PROCEEDINGS are exhausted; there are so many calls for single copies of these numbers that the Institute offers to pay for copies thereof returned in good condition at the rate of 75 cents per copy.

ANNAPOLIS, MD., November 15, 1920.

INFORMATION INDEX

PAGE

ADVERTISEMENTS, INDEX TO I
PUBLICATIONS, U. S. NAVAL INSTITUTE ..... (2)
SPECIAL NOTICE 2052
TOPICS FOR ESSAYS 2053

PROFESSIONAL NOTES

PREPARED BY

LIEUT. COMMANDER H. W. UNDERWOOD, U. S. Navy

GENERAL ARRANGEMENT

VESSELS BUILDING. NAVAL POLICY. MATÉRIEL. PERSONNEL. MERCHANT MARINE.
- France 2005
- Great Britain 2008
- Japan 2014
- United States 2018

AERONAUTICS 2024
ENGINEERING 2028
NAVIGATION AND RADIO 2032
MISCELLANEOUS 2034
CURRENT NAVAL AND PROFESSIONAL PAPERS 2039

FRANCE

COAST DEFENCE.—The news transmitted by our Paris correspondent that the guns of condemned French battleships are to be used for augmenting the defences of the principal ports will have surprised many readers, who were probably under the impression that the chief harbors of the Republic were already equipped with powerful defensive works. Brest, Cherbourg, and Toulon have always been regarded here as fortresses of the first rank, but our correspondent shows this impression to be wrong. Their heaviest armament appears to consist of "a few short-range 240 mm. (9.4-in.) guns," which certainly could not have beaten off an attack from the sea by modern capital ships. The Germans no doubt were fully apprised of the comparatively defenceless state of the French coastline, for it is now known that in the closing days of July, 1914, they were preparing a series of naval attacks on the Channel ports of our ally. The responsibility for coast defence, which was formerly in the hands of the army, has now been transferred to the navy, but it does not appear that money is to be spent on elaborate fortifications. The French view is that the fixed defences of a harbor may safely be limited to a few heavy quick-firers sufficient to repel cruiser raids, leaving submarines to protect the coast from bombardment by dreadnoughts. We notice, however, that stronger works, armed with supercaliber guns, are recommended for particularly exposed ports, such as Dunkirk, Cherbourg, and Bizerta. It cannot be said that the war has taught us anything new in regard to coast defence. The Germans converted the Flemish seaboard between Westend and Knocke into a seemingly impregnable rampart, but the Zeebrugge exploit showed that no fixed defences are capable of resisting a surprise attack if it be skilfully conceived and carried out by determined men. Heligoland was another disappointment to the enemy, for its monster guns and powerful rock batteries failed to prevent our forces from penetrating on occasion well into the sacred Bight. The aversion to brick-and-mortar defences was doubtless carried too far in the case of our Northern bases, which had to

be hastily armed with improvised batteries in the early days of the war. But it is certain that no case has been made out for spending large sums of money on improving the fixed coast defences of the United Kingdom.—*The Naval and Military Record*, Oct. 20, 1920.

FRENCH VIEW OF SUPER-CANON.—The question of super-canon is the object of much controversy. The Boche "Berthas" that bombarded Paris at 120 kilométre ranges at the rate of one round every 12 minutes might intimidate civilians, but they would have no value whatever for bombarding a fleet on the high sea or for defending a narrow sea passage such as the Channel or the Mediterranean Straits. Quick, accurate fire can alone be effective against warships; and it is a fact that Parisians, who rather disliked night bombardment by airplanes, mostly laughed at the performances of the Berthas. So the most efficient batteries for such exposed positions as Dunkirk, Cherbourg, St. Nazaire, and Bizerta must be made up of the heaviest types of naval ordnance, 16- or 17-inch guns of the latest design, firing at the rate of one or two rounds per minute. But not a few experts, some of them holding posts of influence at Rue Royale, consider the gun as being altogether out of date for coastal operations. Aerial scouting and bombarding flotillas, acting in co-operation with submersibles, are, in their opinion, all that is necessary to control the sea passages round the French coasts. To this contention old officers reply that the gun is reliable in all weathers, whereas the submarine and aerial machines, besides costing much more in construction and upkeep, might turn out to be useless when wanted.—*The Naval and Military Record*, Oct. 13, 1920.

NEW FRENCH NAVAL ERA.—The naval outlook is, in a sense, brighter than at any previous period under the Troisieme République. On paper at least two conditions of maritime greatness are being realized that had ceased to exist for the last 50 years, viz., stability in direction and the presence at the head of the state of "Big Navy" men. It looks this time as if the former policy of spasmodic and vain efforts and of everchanging paper programmes were to make room for a new era of steady and uninterrupted developments along progressive lines. The Marine Française that succeeded in preserving a substantial degree of efficiency when managed in defiance of the laws of common sense and changing heads every few months is, of course, bound to thrive once stability and competence have been restored in its direction. Ministries of 27 years' continuous duration, like that of the great Colbert, or of 17 years, like that of Tirpitz in Germany, are not possible under the Republican régime, and Frenchmen would be satisfied with conditions of stability similar to those that obtain in Great Britain and in the United States, especially if the Chef d'Etat-Major Général can be maintained in his responsible post for a period of four or five years, so as to ensure real authority and continuous progress; and so much is likely to be obtained to judge from the facts stated hereafter.

President Millerand's first official act as President speaks for itself; he maintained in power, contrary to previous practices, and to the intense disgust of professional politicians, the whole Ministerial team he had selected himself in January last. Not only does Minister Sandry remain at Rue Royale, but the new Prime Minister is Mons. Leygues, who was Marine Minister under the Clemenceau Ministry, and is a well-known partisan of a strong navy. The latter may even be claimed to have been our best Ministre de la Marine, so far as eloquence, good intentions, and genuine optimism are concerned. No one has spoken more beautifully of the rôle the French Navy has played in the war. Mathurin and those who command Mathurin have in him a tried friend and an able defender. More than once he has ungrudgingly rendered public justice to the premier services of Jack Tar, and the alliance with Great Britain has in him a convinced and devoted champion. His motto is that of Richelieu, the

founder of the navy: "Sans la marine on ne peut ni soutenir la guerre ni profiter de la paix." He means France to "reprendre sur des bases élargies la vaste politique économique et maritime qu'elle suivit aux grandes époques de son histoire" (Ministerial declaration, October, 1918)—to resume on a wider basis the comprehensive, economical, and maritime policy France adopted at the most glorious times in her history. In truth it must be said he has done nothing to that end beyond discarding the half-completed 25,000-ton Normandies, and the Commission de la Marine bitterly reproached him with failing to utilize the credits Parliament had voted for new construction. But then he had not the power and chances of longevity he now enjoys, and in naval circles much is expected of the new Premier's patriotism and good will, all the more so as he will have an all-powerful supporter in President Millerand, who is a believer in sea power, and has proved, when acting as chairman of the Ligue Maritime, the most go-ahead propagandist that influential association has yet known. Mons. Millerand is thus a naval President, and, up to date, he is the first to have any claim to that title. At no previous time were there in power so many friends of the navy. No wonder, therefore, that a change for the better is looked for in the present rather gloomy naval outlook.

The continuance of the present ministry is a matter for satisfaction. The earnestness, work power, and managing ability of Mons. Landry are unanimously acknowledged. The inadequate 1918 Leygues programme he has considerably enlarged and improved, at least on paper. The 1921 budget, to be discussed next month by Parliament, will mark a first step towards expansion on new lines. Mons. Landry is a silent worker who wastes very little time in empty or showy manifestations; and not only does he work hard himself—and this is the first condition of Ministerial efficiency—but he has the secret of making others work silently, methodically, and effectively. Far more is being prepared and done at Rue Royale than appears on the surface, and there is no justification for the grumbling and sarcasms to which the outward inertia of the Paris Admiralty is giving rise in some quarters. The delay in ordering the projected cruisers and destroyers will turn out in the end to be a good thing for the navy. Had not the constructional programme been thoroughly revised in the light of war experience and of the progress realized by rival navies, inferior units would already be in hand that would not have been worth their heavy cost. Superiority alone pays. It is obvious that cruisers of 30-knot speed, and carrying 5.5-inch weapons, would not only be outclassed by the latest British and American scouts, the mount 7.5- and 8-inch guns, but would, besides, fail to outmatch the cruisers of Mediterranean Powers, which is one of their raisons d'être. France would have been repeating the disastrous blunder the Boches committed with their pre-war Kleine Kreuzer. No amount of eloquence can make up for inferiority in the matter of speed and caliber, and those experts who are arguing about the superlative and exclusive qualities of the 140 mm. are indulging in a gratuitous and childish form of error. Moreover, the enlarged croiseurs légers will be ready as soon as they would have been if ordered six months since, as the result of improved constructional methods.

The "cuirasséphobie" or wave of antagonism to the battleship that swept through the service in 1918-19 (Admirals Daveluy, Buchard, Degouy, and so many others joining in the fray against the mastodon) is visibly abating Mons. Landry, who at first entered Rue Royale with the avowed intention to "supprimer les cuirassés qui n'ont rien fait pendant la guerre," has come round to less extreme and more sensible views since he felt the supreme responsibility on his shoulders and has come into closer personal contact with the comprehensive and thorny problem of sea power. With the best-informed naval opinion he merely holds that pre-war battleship designs no longer meet present requirements, and are in need of a thorough revising. Far from considering the big armored fighting ship as a thing

of the past, he has given every encouragement to the ballistic and explosive experiments and researches conducted under the supervision of Artillery General Charbonnier with a view to maintaining France's lead in the ballistic line.

President Millerand and Premier Leygues are agreed with Minister Landry and our acting First Sea Lord, Admiral Salaun, that France must finally give up all thought of competing for size with either Great Britain or the United States of America, but nevertheless that she has the duty and means of remaining a first-class power and of commanding the respect of her neighbors, provided she (1) keeps a fleet superior in quality and efficiency to any continental rival and utilizes (2) her unique strategic assets to eventually ensure her command of the most important European sea routes, besides (3) acquiring a predominance in the field of invention, where Frenchmen have all along been pioneers. The unreliable and changing politics of our first Latin sister, Italy, her rumored alliance with our second Latin sister, Spain, that is preparing a programme of three 25,000-ton battleships, five 6000-ton cruisers, and 160 destroyers and submarines to be ready in 1927, are developments having a direct influence on the Mediterranean situation, despite the friendly sentiments of Frenchmen for their Southern neighbors. As noted by Premier Loygues, peace is only secure so long as there is sufficient "force au service du droit" ("Right supported by might").

The five scouts, surrendered by Bocheland and Austria, which the French Navy is authorized to put in commission, have been renamed Strasbourg, Metz, Mulhouse, Colmar, and Thionville, after cities of recuperated Alsace-Lorraine. There is everything to praise in this fitting nomenclature that will call the attention of the new provinces to the navy, and also in the decision to name surrendered Boche flotilla units after "marine morts pour la patrie dans des circonstances particulièrement héroiques." The largest destroyers revive the memory of Rear-Admiral Senès, who perished in the torpedoed Gambetta; of Capt. Rageot de la Touche, who went down with the Bouvet in the Dardanelles; and of the brave Captain Delage, who chose to go down with his ship *Danton* as commanded by the old sea tradition. For some reason the name of the gallant Captain Guépin, who sank in the *Suffren*, is not to be found in this list of posthumous honors that even includes heroic petty officers and ordinary seamen like Maitres Jean Corre, Second-Maitre Pierre-Durand, Matelot-Leblanc. In every ship an inscription will commemorate the brave deeds and the noble example of those heroes of the grande guerre. Thus an epoch-making departure in Gallic naval nomenclature and a sign of the times.—*The Naval and Military Record*, Oct. 6, 1920.

GREAT BRITAIN

LESSONS FROM JUTLAND.—The long delay in issuing to the public the official narrative of the battle of Jutland, as compiled by the Harper Committee, has caused some disappointment. There have been rumors that certain officers who took a leading part in the action are dissatisfied with the official record of their movements, and have insisted on a revision of vital passages in the narrative. The Admiralty, on the other hand, explain the delay on the ground that new and important evidence has come to light. Everyone who has examined the data already published in relation to this action will appreciate the difficulty of preparing an even approximately full and faithful account of the greatest sea fight in history. Hundreds of vessels were present, the slowest of which could travel at a speed of 18 knots, and the major fighting was done by ships of 25 knots speed and more. No human eye could take in this vast kaleidoscope and receive a true impression of it at any given instant, much less follow each of its countless changes and yet retain at the end a clear picture of what had happened at

every stage of the twelve-hour spectacle. To a large extent, no doubt, the uncertainty which prevailed in regard to the principal phases of the battle has been cleared up by inspection and comparison of the ship's logs, but even here the evidence is known to be seriously at variance, and the means of checking it are not always available. On the whole we consider that Captain Harper and his assistants have had a most ungrateful task to perform, and we shall be surprised if the appearance of the narrative does not evoke a very heated controversy.

We do not anticipate any particularly significant disclosures in regard to the tactics of the opposing fleets. Thanks to the books written by Admirals Jellicoe and Scheer respectively, the essential features of the battle are now well known. It began with a fierce action between the British and German battle-cruisers, in which we suffered heavy losses only partially balanced by the damage we inflicted. This phase was succeeded by a brief encounter between the two main bodies, during which our battle fleet established a definite superiority and so mauled the enemy that his subsequent movements were guided solely by a desire to break off the action and escape. The third and concluding phase witnessed the heroic work of our destroyer flotillas, whose incessant attacks confirmed the Germans in their resolution to regain the shelter of their harbors, and incidentally cost them several good ships. Of the sequel little need be said. Scheer, it is true, did make a perfunctory sortie three months later, but by his own admission he was not at all anxious to join battle again. Jutland took the heart out of the German High Sea Fleet. Thereafter it was no more than a passive pawn in the game, and, except for the support it afforded to the U-boats, it had become virtually a negligible factor. In these circumstances we venture to say that the interest attaching to future discussions on the tactics of the battle of Jutland will be mainly academical. It was the third and last of a series of engagements which convinced Germany that she had nothing to hope for from her battle fleet. The first great blow was struck in the Bight on August 28, 1914. the second at the Dogger Bank on January 24, 1915, and the knockout was administered at Jutland. On that fundamental point German and British evidence is entirely in accord.

We do not, however, suggest that the material for investigation has been exhausted. We believe, on the contrary, that lessons of the utmost value may be learned by studying the details of the action. It was especially fruitful in data concerning the relative value of naval weapons. The advantage of superior speed was clearly demonstrated at every stage of the fighting, and, although some remarks made this year by Rear Admiral Chatfield seem to imply that the naval staff is dubious as to the value of very high speed in capital ships, we cannot think that staff opinion has been rightly interpreted on this subject. Where the British fleet proved defective at Jutland was in certain features of equipment. The battle-cruisers were found to be lacking in protection, and three of them succumbed to punishment less severe than their opposite numbers in the German fleet had to endure. It is very desirable that the shortcomings in design which caused the loss of the *Queen Mary*, the *Indefatigable*, and the *Invincible* should be exposed with a view to rectifying them in subsequent construction. So far as is known the behavior of our guns was quite satisfactory. The shooting was so accurate that, ship for ship, the British fleet registered a higher percentage of hits than the enemy, but the advantage of this splendid markmanship was largely nullified by the poor quality of our projectiles. There is not the least doubt that had our shell functioned properly the German battle-cruiser force would have been wiped out. We paid such a grievous price for this lesson that it would be tragic if we failed to profit by it. It raises in an urgent form the question as to whether the design of ordnance material ought not to be left to private manufacturers, the function of the naval officer being confined to laying

down the requirements of the weapons he is to use. This was the principle which Germany adopted with conspicuous success, and we might do worse than take a leaf from her book.—*The Naval and Military Record*, Sept. 29, 1920.

A NATIONAL AIR POLICY.—The proceedings at the Air Conference have been such as to jusitfy the hope that the foundations of Britain's aerial policy will be well and truly laid. That the government are alive to the vast importance of this subject is attested by the Conference itself, which was arranged by the Air Ministry, and is to be made an annual event. Mr. Winston Churchill assured the delegates that the government intend to help civil aviation by every means in their power. That pledge will do much to dispel the anxiety which had been recently created by the closing down of several well-known aircraft factories and by a growing suspicion that British progress in aviation has been seriously hampered since the war by the unimaginative treatment accorded to commercial flying by officialdom. The intimate relation of civil to military aviation is now obvious to everyone. It is closer even than the relationship between the Royal Navy and the mercantile marine, for, whereas the warship is a type absolutely distinct from the merchantmen, the large aeroplanes now employed on mail and passenger service differ in no essential feature from military machines, and could, in fact, be converted into such at very short notice. Consequently, the dimensions and efficiency of our commercial air service in time of peace will afford a fair index to our air power in case of war. As *The Times* rightly observes, our old insular security is gone, and we must be prepared to defend our existence in the air. The The nearest analogy to air power, it adds, is sea power, and the broad lesson of history is that the nation with the greatest mercantile sea power has been the nation with the greatest naval power. That proposition is incontestable, and it supplies the strongest argument conceivable for encouraging the growth of commercial aviation by every legitimate means.

The raids which German airmen made on this country during the war were not without a certain value, though the effect was very different from that which the enemy anticipated. They caused us but little embarrassment from the military point of view, but they did more than years of propaganda could have done to stimulate public interest in air power. Citizens of every class, and more particularly those who dwelt within the home "war zone," need no reminder of the part that air power is destined to play in the wars of the future. For centuries past we have relied upon the navy to protect us from the horrors of invasion, and within the limits of its power the navy has never failed us. But aviation has bridged the "silver streak" and provided past and future enemies with the means of dealing us overhead blows which the navy cannot parry. Into the problem of national defence a new factor has thus been introduced, and the old formulæ need to be revised accordingly. It is held by some that air warfare is too much of a double-edged weapon ever to come into general use, that the risk—nay, the certainty—of reprisals in kind will deter an opponent, however vindictive, from the raiding cities and industrial centers beyond the war zone proper. But the acceptance of this comforting theory postulates the existence of a formidable air fleet on both sides. Nothing is more certain than that a state deficient in air power would be exposed to merciless raiding by an antagonist who was better equipped in this respect. On the other hand, it is not improbable that two warring states, approximately equal in aerial armaments, would mutually agree to restrict bombing operations to the immediate theatre of war.

Thus, from whatever angle the problem is viewed, the need to build up an adequate reserve of air power is manifest and urgent. The present difficulty is mainly one of finance. Those enterprising firms which have done pioneer work in opening up the home and transmarine airways are entitled to specially considerate treatment, for they have shown the nation

how to protect itself against a new and serious menace. As merchant adventurers of the air they deserve the same sympathy and support that was extended to the seafaring pioneers of Elizabethan days, who made the markets of the world accessible to English commerce and founded British sea-carrying supremacy on an enduring basis. To a certain school of economists the word "subsidy" has an alarming sound. In general the principle of allowing a new industry to find its own feet is a good one. But the case of air traffic is altogether exceptional, bound up as it is with the safety of the realm. It is to be gathered from Mr. Churchill's remarks at the Conference that the Government are ready to grant direct financial aid in developing commercial flying. That is a big point gained, and, now that it has been conceded, the leading aviation firms will have a greater inducement to carry on. The record of the London-Paris air service during the last year is such that the postal authorities need have no qualms about entrusting the conveyance of all first class continental mails to the air line. If this experiment proved a success the system could be gradually developed until in time a perfect network of air routes had been created, giving constant employment to a large number of pilots and machines and encouraging healthy competition among the manufacturers. In this way we should commence to build up that formidable reserve of air power which is no less essential than navy and army to the future security of the nation.—*The Naval and Military Record*, Oct. 20, 1920.

AN ABBREVIATED "HOLIDAY."—Slowly but surely the conviction gains ground that the "naval holiday" which we promised ourselves at the close of the war will be of much shorter duration than was anticipated. Early in 1919 it was, we believe, suggested by Mr. A. Hurd that naval shipbuilding might be suspended for five years without endangering British supremacy. At that time there was some reason to hope that the large programmes in course of execution in the United States and Japan would be arrested, or at any rate modified, as the result of an international agreement for the limitation of armaments. That hope has not been fulfilled, and the two Powers in question are steadily enlarging their naval establishments. It is therefore of interest to consider how our relative standing would be affected if we forbore to lay down any new ships until January, 1924, *i. e.*, the date on which the proposed five years' "holiday" would expire. By then we should no longer be supreme in capital ships, which, according to the Admiralty, still constitute the backbone of naval power. The United States Navy would enjoy a marked preponderance in this type. Its battle fleet, although but little stronger numerically, would consist of more modern material, and in gun power would be from 50 to 70 per cent superior to ours. By the same date the Japanese Navy will include eight ships—four battleships and four battle-cruisers—of a more formidable type than anything we possess. When it is remembered that these two navies are at the present time building a total of 24 capital ships, all of which are to be armed with 16-inch guns, it must be perfectly obvious that British supremacy is fast disappearing.—*The Naval and Military Record*, Oct. 13, 1920.

AIRCRAFT CARRIERS.—Pursuant to orders, the new aircraft-carrier *Eagle*, which has been undergoing trials in the channel since entering into commission last April, is now joining the Atlantic fleet in place of the *Argus* while the latter is refitted at Devonport. While nothing of an official nature has been given out as to the trials of the *Eagle*, it is freely rumored that the ship has been found lacking in qualities which are essential to the function she is designed to perform. Originally begun as a battleship—a sister to H. M. S. *Canada*, lately resold to Chile—the decision to convert her into a carrier of aircraft was taken at a time when there was rather a craze for this type of vessel, but in her case the inspiration was not a happy one. The first requirement of any ship intended to work with aircraft is high speed, and this the *Eagle* does not possess. She is also

criticized as too large, unwieldy, and expensive. What she has cost the country up to now remains a secret, but rumor has it that the bill falls not far short of four millions. At any rate, the fleet flying men are not enamored of their latest acquisition, and it is believed that the idea of employing her permanently as a substitute for the *Argus*—a remarkably successful ship—has been dropped. The Chilean Government, it is said, has offered to purchase her, provided she is reconstructed as a battleship. If this work could be done without entirely swallowing up the purchase price it might be worth while to accept the offer.—*The Naval and Military Record*, Oct. 6, 1920.

THE LIGHT CRUISER "RALEIGH."—H. M. S. *Raleigh*, a light cruiser of what is officially designated the "improved *Birmingham*" class, reached Devonport last month to be prepared for commissioning as flagship on the North America and West Indies station. The designs, prepared in the summer of 1915, were based on the principles of an extensive cruising radius, ability to steam far and fast in any part of the navigable globe, and an unusually powerful armament. The dimensions, etc., are as follows: Length between perpendiculars, 565 ft.; length overall, 605 ft.; breadth, extreme, 65 ft.; mean load draught, 17 ft. 3-inch; displacement, 9750 tons; shaft horse-power, 60,000; speed at load draught, 30 knots; fuel at load draught, 1000 tons; maximum fuel capacity, 1500 tons of oil plus 800 tons of coal. Armament: Seven 7.5-inch B. L., twelve 3-inch (including four anti-aircraft) Q. F. guns, six 21-inch torpedo tubes. Protection: Side amidships, 3 inch-2 inch.; forward and aft, 2½ inch-1½ inch; 1 inch after bulkhead, 3 inch conning tower, 1 inch upper deck amidship, 1 inch lower deck aft. These ships were the first light cruisers to be provided with bulges as a protection against torpedo attack. The bulges are of a modified form, 10 ft. deep; but owing to the slope inboard of the side of the hull the projections have no serious effect on speed. A perpendicular from the top of the side would just touch the edge of the bulge amidships.

The ships, it will be observed, were originally designed to burn oil and coal—this in view of the possibility that oil supplies might not be always available in the more remote ports of the world. Subsequently, however, this arrangement was altered in three ships of the class to oil only, the original power of 60,000 shaft horse-power on the four-shaft geared turbine installation being increased up to about 70,000 shaft horse-power in consequence of the change. The *Raleigh* has eight oil-fired boilers, each with a heating surface of 7650 square feet, and four boilers fired either by coal or by oil, each having a heating surface of 4675 square feet and a grate area of 77 square feet. It is estimated that, with only four coal-burning boilers in use, enough steam would be generated to propel the ship at a moderate speed. The turbines are of the Brown-Curtis impulse type, the high-pressure turbine running at 3200 revolutions per minute at full power and the low-pressure 2150 revolutions, geared down to give a speed of 420 revolutions per minute to the four propellers. The boilers and turbines, with their gearing, form a remarkably compact power unit, and take up little more than one-third of the total length of the ship. The auxiliary plant includes fifteen Weir feed pumps and twelve steam-driven fans for the three boiler-rooms. The oil-fuel pumps, heaters, and filters are situated in the boiler-rooms. Each engine-room contains two Allen dynamos of 105 kilowatts, driven by compound reciprocating engines, for generating the electric power and light. The main steering engines are of the three-cylinder type. The auxiliary steering is on the Hele-Shaw electric system. As the *Raleigh* is to serve as a flagship in tropical climates, extra refrigerating machinery has been installed.

The official trials of the *Raleigh* began on September 5. Final progressive trials, working up to full power runs of four hours' duration, were carried out on three successive days, at powers varying from 3000 up to the maximum of 71,350 shaft horse-powers, at which latter figure a speed

of 31 knots was achieved, which is considerably better than the performance of the two earlier ships of the class, *Hawkins* and *Vindictive*, in which four boilers are coal-fired. At full power the *Hawkins* made 29.5 knots, while the *Vindictive*, with a maximum of 63,600 shaft horse-power, touched 29.12 knots. With regard to the general behavior of the *Raleigh's* machinery, Messrs. Beardmore, the builders, write to us as follows: "On these trials the cruising turbines came in for severe testing, and in the matter of steam and oil consumption they showed a saving of oil fuel of some 15 to 20 per cent at the economical cruising speed of 16 to 17 knots. This was due to the extra expansion of steam when utilizing the cruising turbine at the forward end of the high-pressure turbine. The very notable performance of the machinery was revealed by the fact that which one-half of the nominal power, *i. e.*, with 35,000 shaft horsepower, a speed of 28 knots was actually attained on the course. H. M. S. *Raleigh* turns out to be a remarkably steady gun platform, and in the matter of vibration it was hard to tell that such high speeds were being attained. The machinery performed admirably, and the noise of the single-reduction double helical gearing was not obtrusive."

The ships of this type represent a distinct advance in the development of the protected cruiser. "Light cruiser" is really a misnomer when applied to vessels of nearly 10,000 tons; on the other hand, the fact that the *Raleigh* and her sisters have 3-inch plating on the sides does not justify their inclusion in the armored cruiser category. As protected cruisers they are very remarkable ships. Their speed would enable them to run down any light cruiser completed to the present date, and their armament would make them dangerous opponents to anything less than a capital ship. Although they were built primarily for the protection of ocean trade, they would be no less formidable in the aggressive *rôle* of commerce destroyers by virtue of their high speed, extensive radius, and powerful artillery.

For the next few years, at least, the *Raleigh* and her sisters will be the most powerful protected cruisers in the world. In speed they may be surpassed by the ten American vessels now being built, which are designed for 35 knots, but in every other quality the British ships will be far superior. This fact has been so far recognized abroad that the General Board of the United States Navy is advocating a new type of cruiser with a main armament of 8-inch guns; while the French authorities are said to be considering designs for a group of light cruisers with a 7.6-inch armament. The *Raleighs* are, perhaps, open to criticism on the score of cost, for £1,500,000 is without doubt a large sum to pay for a cruising ship. Still, considering the present depreciation in money values, their cost compares not unfavorably with that of the *County* class, which averaged £775,000 per ship. We would like to add that, in our opinion, the design of the *Raleigh* class is a remarkably successful one, reflecting great credit on the skill and enterprise of the Naval Construction Department of the Admiralty.—*The Engineer*, Oct. 15, 1920.

SHIPPING IN WAR TIME.—It may certainly be hoped that the experience gained by the government in handling shipping will be embodied in a suitable form and kept up to date by the Imperial Defence Committee for use in any future emergency. Such an emergency, it may be hoped, is in the far distant future, but the important thing is to be prepared. For the general public, one excellent means of knowing how great a part was played in the late struggle by our great shipping concerns is in the series of books which some of them have issued containing records of their war work, and to which various references have been made in these columns. Doubtless other steamship companies will be putting out their war narratives, for material is plentiful enough. For example, the Clan Line, with the *Clan McTavish*, and the Pacific Steam Navigation Co., with the *Ortega*, indicate how interesting these may be. The spirited fight

of the former with the *Möewe*, the disguised German raider, in January, 1916, ought certainly to be recorded in some permanent manner; and so, too, should the ingenuity and resource shown by the crew of the *Ortega* in escaping from the *Dresden* by running into the Magellan Straits.—*The Army and Navy Gazette*, Oct. 2, 1920.

JAPAN

STRATEGY IN THE PACIFIC.—A message from Tokio reports that Japan is engaged on a program of submarine construction, and that, pending the erection of buildings ashore, the old battleship *Shikishima* has been commissioned as depot ship for the submarine flotilla. It was first announced in our columns, early this year, that the Japanese authorities had decided to lay down a number of big submersible vessels, closely modelled on the notorious German U-kreuzer type, one of which was ceded to Japan by the Allied Naval Council. The largest completed vessel of this type was the *U-142*, displacing 2158 tons, with a cruising radius of 20,000 miles and a maximum speed on the surface of 18 knots. She was armed with six torpedo tubes and two 5.9-inch guns, and carried a complement of about 80. It is fairly obvious that a submersible of this description would be better adapted to operations in the Pacific than in the comparatively restricted waters of the war-time submarine zone. There is no precise information as to the characteristics of the large Japanese submersibles now in hand, but unofficial reports are such as to suggest that their design has been influenced by the requirements of commerce destruction. Since Japan is not building her fleet for fun, her naval program is naturally based upon the peculiar strategic conditions that would prevail in the event of war with a first-class power, such as the United States. The rapid growth of the American mercantile marine has made the latter country more vulnerable to naval attack than she has been for 60 years, and in case of war with an opponent who was well supplied with fast light cruisers and ocean-going submarines of great endurance she would almost certainly suffer heavy losses in shipping. It is no secret that the progress of the Japanese naval program, coupled with the recent recrudescence of friction on the subject of Japanese immigration into California, is causing perturbation in Washington. Mr. Daniels and Admiral Benson still consider it expedient to utilize the bogey of British "navalism" as an argument for enlarging the United States fleet, but we doubt whether any shrewd American is deceived as to the true purpose, underlying the big building programs adopted by his government in recent years.—*The Naval and Military Record*, Sept. 29, 1920.

JAPAN'S FINANCIAL CRISIS.—If stupendous growth can ever be really healthy, Japan enjoyed her healthiest development during the war. The call for exports was unlimited. The possibilities of import were strictly limited, and Japan had, as far as possible, to supply her own needs while catering to the needs of other nations. There were wild extravagancies by certain profiteers. Freights at 1500 shillings a ton brought prosperity to the geisha as well as to the shipowner, but on the whole it was an industrious, frugal and highly remunerative life.

One shadow oppressed it—the fear that even the best of wars must end. False reports caused minor panics, but these "Wolf!" cries soon ceased to have any affect. During the latter days of the German retreat, when it became certain that the end was near, some of the bigger men unloaded, and this caused a heavy slump when the armistice was signed, but it was the realization of this unloading rather than the armistice itself which caused the depression, and it quickly passed away. It soon became apparent that business was going to be better than ever—that, until Europe's industries were reconstructed, the world wanted everything Japan could make.

But Japan was near the end of her manufacturing resources. Her machinery was worn out, and her own natural products were few. It was necessary to refit. Money was plentiful, and there now became a remarkable swing around in the balance of trade. This balance of trade, it may be mentioned, had for years been a nightmare to Japanese statesmen. Japan was a debtor country, but she imported more than she exported, nor could the most unreasonable of tariffs bring about the "favorable" balance desired. How the war and the boom after the war affected this balance may be best seen in a few figures, as shown in the following table:

TABLE SHOWING WAR'S EFFECTS ON TRADE BALANCE OF JAPAN

	Imports Yen	Exports Yen	Excess Yen
1914	595,735,000	591,101,000	*4,634,000
1915	532,450,000	708,306,000	†165,846,000
1916	756,428,000	1,127,468,000	†371,040,000
1917	1,035,811,000	1,603,005,000	†567,194,000
1918	1,668,143,000	1,962,100,000	†293,957,000
1919	2,173,460,000	2,008,873,000	*74,587,000
1920	‡1,617,404,000	1,138,836,000	*478,568,000

*Imports. † Exports. ‡ Six months.

In this table we have in six months an excess of imports not so far short of the value of the whole export trade in the year preceding the war. Yet no small part of it was a provident outlay, spent on raw materials and the machinery for handling them. There was this notable development, however: First, whatever was required was bought regardless of cost; secondly, there was a passion for capitalization; and thirdly, there was an enormous increase in wages. Moreover, the growing figures in the trade totals represent much more an increase in price than in quantity.

THE CAUSES AT WORK.—The first of these items—purchase regardless of price—brought about the chief shock when the inevitable slump came last March, for there was some danger that the whole fabric of finance would collapse through the large advances made on depreciated goods being irrecoverable. In illustration of the passion for capitalization it will suffice here to cite the agitations conducted by shareholders in the Nippon Yusen Kaisha and the Kanegafuchi spinning mills (perhaps the two soundest and most solidly remunerative concerns in the whole of Japan) to force a reluctant directorate to increase capital when they had in hand more cash than they could spend. With these examples of how the fires of speculation were fanned amid the solid timbers, the rapid envelopment of the rest of the structure in devouring speculation may be imagined.

The third factor—the rise of wages—was in some respects the most serious of all. Japan's manufacturers got through their most prosperous time before the labor problem became serious. In August, 1918, the people, exasperated at the success of the rice brokers in forcing up the price of rice far above the increase in wages, rioted all over the country. But the post-war boom was just then at its beginning. It was realized that labor unrest during this period would ruin everything, and since then it has been a case of "ask and have." The orderly strike has been developed into a fine art, and during 1919 there was an all-round increase in wages so extraordinary that in some lines of skilled workmanship wages are in excess of the pre-war British level, without half the British efficiency. The fact that costs of production in Japan had become higher than in America was attracting serious attention when the slump came. There had, however, been no more food riots, though prices were higher than ever.

AMERICAN DEMAND FOR SILK.—No single factor contributed so largely to the Japanese boom as the American demand for raw silk. Many a

year it has saved the financial situation, and during the past six years, while it has doubled in quantity, it has more than doubled in price. These figures of the export of raw silk to the United States are illuminative:

	(Roughly 1 lb.) Kin	Yen
1913	13,340,000	125,909,000
1919	27,529,000	600,843,000
1920 (six months)	7,990,000	242,557,000

In spite of the heavy falling off in quantity it will be seen that the price is more than satisfactory. Of silk exports in 1914 the average price was 9 yen per kin. In 1919 it was 21 yen. For the first six months of 1920 it was 30 yen. And this figure of 30 yen is the more remarkable because it includes the months of May and June, in which exports averaged, respectively, 24 yen and 17 yen per kin, besides declining in quantity to less than one-third of the exports of the prosperous months. Nothing contributed more to Japan's present embarrassments, therefore, than the discovery by American consumers that they were paying more than they liked to for "luxury" goods.

The other great industries of cotton manufacture and shipbuilding have also played an important part, and their tribulations have contributed largely to the present general depression. In shipbuilding the decline has not been nearly so great as might be assumed from the fact that of 160 shipyards over 120 are wiped out. These 120 were nearly all very small concerns, many of them constructors of wooden ships that often did not survive one voyage. The order taken for the United States Shipping Board (the famous "ships for steel" contract) has held up the shipbuilding industry, and now that a slump has become unavoidable the enormous navy estimates passed by the extraordinary session of the Imperial Diet in July insure ample work in all the principal yards for a long time to come. Much more serious in connection with shipping is the loss of the war monopoly, the entry of American competition and the decline in freights. Apart from the favorable balance of trade, the high freights earned by Japanese ships during the boom in themselves an enormous revenue—though visible only in a growing fleet, great office blocks, and 100 per cent dividends.

There is now a prospect of much idle shipping. The running of Japanese ships, owing to the forcing up of wages, is no longer cheap. It is said to come between British and American. And there is a bitter struggle now going on over the reduction of wages and the increasing employment of Chinese. The California attitude toward the Japanese farmer is mild and benevolent compared with the Japanese sailor's attitude toward the Chinese interloper.

PROFITEERING IN COTTON GOODS.—As regards the part the cotton industry has played in the depression the Chinese boycott has been much exaggerated. In no great industry was the profiteering so gross as in cotton. The brokers had the whole yarn trade in their own hands, making long forward contracts with the mills and combining to keep up prices. The falling off in the export of yarn in China was due less to the boycott than to this exaltation of price. Exports were, of course, much cheaper than domestic prices (that is the case with nearly all Japanese products), but they were not cheap enough. However, it was one of the complications of the trade that the brokers sold the yarn to the weavers for less than it cost them, and took the product at their own price, and as the increase in exportation of piece goods to China increased vastly more than the export of yarn declined, it is obvious that the boycott, though it undoubtedly worried certain retailers in China, had no very profound influence on trade.

The immediate cause of the slump was the Bank of Japan's action in refusing to lend any more money to the private banks, and its calling in of

the loans falling due. There have been some petty scandals about influential people having the tip to sell out, but that is a detail. The Bank of Japan was wise in the promptitude with which it recognized the fact that American and European prices were going to suffer convulsions. Japan's profits during the war and the post-war boom would amply cover all her commitments, but the orders placed abroad for goods, although largely consisting of equipment for fresh industry, were placed regardless of price. They could hardly be checked while the export trade was also increasing, and while the prices of Japan's chief exports were even more extravagantly in excess of the normal than were those of her imports, the point had been reached where any stoppage in returns (at inflated prices) meant disaster. Cotton and silk were already fluctuating wildly, and the efflorescence of small shipyards had disappeared from the coasts. The Bank of Japan was not a moment too soon.

EFFORTS AT READJUSTMENT.—As for the remedies sought they have been merely relaxations of the bank's decree, with corresponding relaxations filtering downward to the proletariat. The Bank of Japan has been less strict than it promised. A few millions here and a few millions there have been lent for the purpose of stopping a sudden rot, but in the main those concerned have been left to deal in their own way with the situation created by a sudden fall in prices and a cutting off of credit.

Most notable have been the movements of the yarn brokers, whose hold over the mills has already been described. They have seen the price of their commodity decline over 50 per cent in a couple of months, and though they all became millionaires during the boom they are unwilling to disgorge. Many, of course, have not preserved the wherewithal to disgorge, and one or two have sought the popular short cut out of trouble "with a bare bodkin."

Owing to the complications of the trade the mills find it very difficult to dispense with the brokers, greedy parasites as they are, so they have, after much argument, submitted to the following: Sixty-five per cent of their contracts made when yarn was well over 700 yen a bale are being revised to the price on July 9, when it was not much more than 300 yen. The price as between mill and broker was always much less than the market price, so it is impossible to gather any very precise idea of the amount involved, but it is a 65 per cent evasion of contract. Even at this there are some defaulters, and the rest wriggle powerfully to avoid their responsibility and to shift this burden also to the mills.

Meanwhile the mills have to pay their full contract price for forward contracts of raw cotton, and in many cases it is these very brokers dodging their 65 per cent who are insisting on the fulfillment of contracts in respect of raw cotton. The mills have large reserves, can raise mortgages, are working short time, and can cut wages. Against all these resources the broker can only cut his throat. So the shareholders and the work people pay. Similar compromises have been made in many trades, the flannelette compromise being one in which there has been particularly acrimonious discussion. "Compromise" Japan always means the partial foregoing of a legal claim or the partial submission to an illegal one. Fertilizer also provides a salient example of the compromise system, and it is mentioned here because the fertilizer trade exhibits very markedly another of the expedients adopted in order to ameliorate the depression. Sulphate of ammonia and Chilean nitre are being exported to any customer abroad who will offer a passable price. The idea is not to be content with a small profit or even to cut a loss, but to create such a shortage in Japan that a good profit may, after all, be wrung from the consumer. Pulp has been re-exported in large quantities, and many other commodities. Then there are the re-exports of goods of which the importer simply cannot (or will not) take delivery, the more honorable of such firms asking the seller to dispose of the goods elsewhere at their risk and expense.

MANY ORDERS CANCELLED.—And, of course, cancellations have been enormous. It has to be remembered that the stoppage came just when buying was in full state. Though America had more than taken the place of Britain as a supplier to Japan, it is probable that Britain has suffered more by cancellations. The falling off in British exports to Japan was more in consequence of the ruin of British industries by the war than for lack of orders. Since the war orders have been pouring into Britain in vast quantities, in spite of it being impossible to promise early delivery. Just as British industry was getting into its stride again for the execution of these orders they were all cancelled. It is stated (in the Japanese press) that two months' cancellations of orders for British woolens amount to 60,000,000 yen.

The end is not yet. The smaller concerns have mostly cut their losses, and are beginning to move again, but the bigger ones are still in the quagmire. Nobody fulfills his contracts, and so the losses are passed on, but there have been few big failures, and the biggest firms are often in the most precarious position. One of the largest lately refused to take delivery of a consignment of so easily disposed of and so profitable a commodity as heroin.

Meanwhile the banks, by their extreme caution, have long since emerged from their penniless condition, and are, while refusing the safest advances, complaining of the lack of profitable fields for the investment of funds. At this moment comes an issue of government bonds, and the Siberian adventure makes it certain that these issues will greatly increase in the near future. This leaves it an open question how far it was pure astuteness and how far a warning of military necessities which caused the Bank of Japan to close down at the moment it did.—*N. Y. Times Current History Magazine*, November, 1920.

UNITED STATES

OUR DIVIDED NAVY.—The glowing announcement given out from Washington on July 27 of the great feats that are to be performed near Panama when our Atlantic and Pacific fleets come together in January shows a conception of naval power that is not only deplorable but dangerous. It evidences a belief on the part of the persons who made the announcement that naval power consists mainly, if not wholly, in a large aggregation of large ships carrying large guns and torpedoes. If it does not evidence this state of mind, it evidences an attempt to persuade the people of the United States that such are the constituents of naval power.

The idea that mere aggregations of men and material constitute fighting forces is as old as history and is one of the most serious mistakes that history records. Under the influence of such ideas the Persians sent their enormous hordes to fight against Alexander; the savages of Gaul hurled themselves against the phalanxes of Cæsar, and the Austrians and Piedmontese took the field against Napoleon. Under the influence of ideas exactly the reverse. Alexander, Cæsar and Napoleon crushed the unskillfully trained hordes that came against them. Under the influence of such ideas as the announcement from Washington discloses, all the inefficiently trained and led forces in all the wars of history went down. Under the influence of ideas exactly the reverse, all the great commanders of history have led their armies and fleets to victory.

If there is any one fact that history proves more clearly than any other fact, it is that any fighting force, in order to serve the purpose for which its nation maintains it, must be drilled as a single fighting force. The reason that a club is so effective as a weapon is because it is not a loose aggregation of molecules, weakly held together, but a compact and coherent mass, all of whose particles are firmly held together, each part supporting every other part and forming together a single unit, which can be directed to a given definite purpose. The whole effort of organization and training is

NAVY DEPARTMENT—BUREAU OF CONSTRUCTION AND REPAIR

VESSELS UNDER CONSTRUCTION, UNITED STATES NAVY—DEGREE OF COMPLETION, AS REPORTED OCTOBER 31, 1920

Type, number and name	Contractor	Per cent of completion			
		Nov. 1, 1920		Oct. 1, 1920	
		Total	On ship	Total	On ship
Battleships					
44 California	Mare Island Navy Yard	94.5	93.2	94.2	92.6
45 Colorado	New York S. B. Cpn.	61.3	55.9	59.5	54.2
46 Maryland	Newport News S. B. & D. D. Co.	84.	83.	81.6	80.4
47 Washington	New York S. B. Cpn.	52.7	43.4	51.5	41.9
48 West Virginia	Newport News S. B. & D. D. Co.	35.5	22.5	33.5	19.5
49 South Dakota	New York Navy Yard	16.2	8.	15.4	7.6
50 Indiana	New York Navy Yard	12.8	4.6	12.1	4.3
51 Montana	Mare Island Navy Yard	13.2	6.2	12.6	5.
52 North Carolina	Norfolk Navy Yard	17.4	10.3	15.4	9.4
53 Iowa	Newport News S. B. & D. D. Co.	9.4	6.6	7.7	4.6
54 Massachusetts	Beth. S. B. Cpn. (Fore River)	....	....	....	....
Battle Cruisers					
1 Lexington	Beth. S. B. Cpn. (Fore River)	3.2	.4	2.1	.3
2 Constellation	Newport News S. B. & D. D. Co.	2.2	.6	1.7	.3
3 Saratoga	New York S. B. Cpn.	5.8	3.2	4.2	1.1
4 Ranger	Newport News S. B. & D. D. Co.	8.	.2	.8	.2
5 Constitution	Phila. Navy Yard	1.2	.4	1.1	.4
6 United States	Phila. Navy Yard	1.2	.4	1.1	.4
Scout Cruisers					
4	Todd D. D. & Const. Cpn.	78.1	68 9	70.1	61.4
5	Todd D. D. & Const. Cpn.	68.	62.7	61.4	52.6
6	Todd D. D. & Const. Cpn.	45.8	26.8	40.6	19.6
7	Beth. S. B. Cpn. (Fore River)	23.	12.	18.2	8.7
8	Beth. S. B. Cpn. (Fore River)	21.4	10.4	17.	7.5
9	Wm. Cramp & Sons Co.	55.	.....	53.	....
10	Wm. Cramp & Sons Co.	54.	.....	52.	....
11	Wm. Cramp & Sons Co.	32.	.....	29.	....
12	Wm. Cramp & Sons Co.	31.	.....	29.	....
13	Wm. Cramp & Sons Co.	24.	.....	22.	....
Miscellaneous					
Fuel Ship No. 17, Neches	Boston Navy Yard	Comm. 10/25/20		98.5	98.5
Fuel Ship No. 18, Pecos	Boston Navy Yard	42.5	39.	39.	34.5
Gunboat No. 22,	Charleston Navy Yard	37.1	25.3	61.4	49.4
Hospital Ship No. 1, Relief	Phila. Navy Yard	99.	98.8	98.5	98.
Amm. Ship No. 2, Nitro	Puget Sound Navy Yard	99.4	98.2	99.2	97.6
Rep. Ship No. 1, Medusa	Puget Sound Navy Yard	42.7	32.	42.	35.
Destroyer Tender No. 3, Dobbin	Phila. Navy Yard	36.5	36.	31.5	31.
Dest. Tender No. 4, Whitney	Boston Navy Yard	5.	2.	3.	1.5
Sub. Tender No. 3, Holland	Puget Sound Navy Yard	7.5	....	6.	....
Aircraft Tender, Wright	Tietjen & Lang	65.	....	....	....

There are in addition to the above, under various stages of construction 45 destroyers, 47 submarines, and 2 sea-going tugs.

There were delivered during October, 1 fuel ship (*Neches*), 7 destroyers, 1 submarine and 1 sea-going tug.

Authorized but not under construction or contract, 1 transport, 12 destroyers and 7 submarines.

to make the various component parts of a fighting force to resemble a club as nearly as possible; to the end that in the hands of its commander it can be directed as a unit to a single definite purpose and inflict a definite blow at a definite point.

The smaller an organization is, the more easily this unity of purpose and directness of effort can be attained. But even with the nine men who constitute a baseball team or the eleven men that constitute a football team, a great deal of the most intensive effort is required, despite the fact that very few men are to be trained to act together, and that the material which they work with is of the simplest possible description, consisting merely of a ball and a bat. The greater the number of men in any organization and the greater the skill required to manage the mechanism, the greater the difficulty, of course, in accomplishing the unity of effort needed. Not only this, but the greater the difference in the ultimate results which an organization can accomplish, if it be well trained or not trained. This means that the larger and more important an organization becomes the greater are the difficulties met in achieving unity of effort, but the greater the necessity for achieving it.

The most powerful organizations in the world are fleets. Without doubt the British fleet is the most powerful military organization in the world. It is the most powerful not only because it has the greatest number of fighting ships and fighting men, but because the influence of Admiral Lord Fisher, reinforced by the effects of the great war, have made the British fleet so compact, so coherent, so thoroughly trained, that all its units are simply parts of one great unit that can be used as a veritable club against Great Britain's enemies.

In other words, the British Navy is an organization that was not thrown together haphazard and thoughtlessly, but an organism embodying not only mere material strength but brains. The direction of the British Navy has been able and skillful. Can this last remark be made about the United States Navy?

If any thoughful man goes on board any of our ships and observes the skill and precision with which all work is done, he would surely declare in the affirmative. But the same thoughtful man, with further knowledge of the operations of the Navy Department itself, would surely answer in the negative. He would surely answer in the negative because he would see that, although the individual ships are good materially, and although there are many good ships of all classes, yet the ships are so deficient in personnel, and the personnel therefore have so little opportunity for really performing their work effectively, that the ships themselves are not effective fighting units. He would find also that the navy as a whole is weak in the place where it is most dangerous for it to be weak, that is, at the head. He would find (doubtless to his great surprise) that although the United States has a navy, it has no fleet!

This thoughful observer would find that, instead of having one grand fleet, as Great Britain has, it has two fleets, neither of which is grand at all. He would find that not only are our naval vessels put into two divided fleets, instead of into one grand fleet, but that these two fleets are out of supporting distance of each other and are, in fact, in two separate oceans—the Atlantic and the Pacific. He would find that, despite the facts that the United States Navy was the first to establish a Naval War College, and that this Naval War College is admitted to be the best in the world, and despite the fact that the navy includes scores of officers who have graduated from this college and many other officers who have taken its correspondence course—yet nevertheless the teachings of this War College are openly and flagrantly violated in the management of the fighting force of the navy!

The most open and flagrant violation of the teachings of the Naval War College is the dividing of the American naval force into two fleets, unsupported by each other, unable to maneuver together continuously as one

fleet, and unable, therefore, to fulfill the purpose for which they were created and are now maintained by the United States.

Experience has shown that a year is all too short a time in which to carry out the exercises and maneuvers necessary to make a fleet efficient as a real fighting force; yet the Navy Department calmly announces that not only are the two fleets to remain separated, but that even their junction in January, 1921, is to be so brief that "exercises and drills will be simple and mainly of a competitive nature, including unofficial athletic competitions between representatives of the two fleets and of individual ships. The main object of the mobilization will be to give officers and men an opportunity to compare notes and meet for a few weeks of good-natured rivalry."

Such a naval junket is a senseless waste of government money; and any attempt to persuade the people that it constitutes a useful mobilization is to make fun of naval training.—*N. Y. Times.*

WANTED—A NAVAL POLICY.—We have a considerable navy, somewhat unbalanced, and a building program for the near future, but the navy is undermanned. Ships no more constitute a navy than guns constitute an army, or land and implements a producing farm or vaults and currency a going bank.

We have more than one naval problem, notably the division of the fleet and the question of the authority of a board of naval experts or of a civilian secretary of the navy for naval operations.

The presidential campaign just closed, for reasons of political prudence perhaps, in both party platforms and public discussion, turned upon other issues. The administration-elect is without a popular mandate concerning military policy Therefore, it behooves the friends of the navy and of intelligent preparedness to busy themselves in the shaping of a naval policy.

By the time this is read the result of the election will be known. Immediately thereafter the ambitious men of the successful party and their friends quite naturally will begin planning for preferment, and party leaders will begin to formulate policies. Between the election and the inauguration the course of the new administration will be laid. From November to March is the period of determination. What the navy is to become in the next four years will depend upon the man who is soon to be selected for Secretary of the Navy, upon the consideration given to naval affairs by the new President and his counsellors, and upon the judgment of the party leaders in Congress. Civilian opinion and political expediency will control, but will be subject to those proper influences which intelligent presentation can readily exercise.

Notwithstanding the high hopes and the fair prospects of some sort of international concert to promote peace, it is plain to all clear-seeing men that world conditions at the moment and in the near future give no promise of American isolation and immunity from strife. Our new foreign trade, our merchant marine policy, our Pacific coast racial troubles, our continuing participation in German occupation, our foreign loans, our frequently expressed concern in the affairs of China and Russia, our dominant participation in the administration of the affairs of Nicaragua, Santo Domingo and Haiti and Libera—all these interests and responsibilities are prolific of military possibilities. In more than one quarter of the world the United States is viewed with jealousy, suspicion or disappointment. Not every nation wishes us well: some would rejoice to embarrass or cripple us.

While no definite crisis impends, very large eventualities are in the making and they will be influenced in form and direction more by our naval disposition and action than by any other factor which we can control.

Before the World War our naval policy was indifference; during the war it was feverish and wasteful haste; since the war it has been hesita-

tion and reaction. Let us now make it something definite, coherent, consistent, purposeful and persistent, so that our people may become steadfast and the world may know precisely what we intend and what we will maintain.—*Sea Power*, November, 1920.

MERCHANT MARINE

PRESIDENT-ELECT HARDING'S MESSAGE TO SHIPPING MEN.—Marion, Ohio, Nov. 3.—The phenomenal emergence of a great American merchant marine is one of the most striking economic consequences of the World War. In 1914 the total tonnage registered for foreign trade under the American flag was 1,066,000 gross tons; to-day, thanks to the quick sense of the American people as to the critical importance of shipping in the world war, and to the invincible genius of American industry in surmounting governmental delay and administrative inefficiency, there is ready for our flag some 12,500,000 gross tons of sea-going vessels.

This importance of our new merchant marine is not alone that it salvages and puts to use a vast and costly body of war material, nor even that it adds a great new activity to the nation's business life, as well as a wholesome safeguard to the country's security; but, more significant still, it provides the mechanism wherewith we can retain and enlarge the economic vantage-ground in world commerce and world finance which we now enjoy.

A well-equipped merchant marine is a prime essential of successful commerce; it is the best agency of trade development. Nothing else will supply the same enterprises in the search for new markets, nor contribute the same energy in the opening up of new trade routes, nor offer the same encouragement for the investment abroad of our surplus capital. Over-seas transportation in American bottoms is of the root and essence of American commercial expansion.

How urgent is the need will appear if we consider the new position of our country in the world trade. In five years we have changed from a debtor nation, owing the world between four and five billion dollars with a varying annual trade balance, sometimes against us, to a creditor nation to whom the world is in debt on capital account some twelve billion dollars, and to whom is due an annual credit balance certainly as great probably much greater, than our prior debit balance.

It is of the gravest national concern that this changed international position shall not work to the injury of our industrial and agricultural life. Larger exports of merchandise from the debtor to the creditor country remain as the line of least resistance, and to this course we must be prepared to see Europe bending every effort. It is the natural way in which restorations from the war must be wrought.

But a flood of imports from debtor countries intent upon stimulating their productive output and aided, even though undesigned, by an unfavorable foreign exchange, would be a bitter experience for the creditor country. We mean to deal considerately, we want to help, but we do not mean to paralyze America to effect a restoration.

From any such invasion we have a right to be saved. Our new merchant marine will do much to avert it. Supplemented, now and whenever occasion requires, by a cautious revision of the tariff, that, while regardful of our changed international position, will effectually safeguard every phase of American industry and agriculture, the new shipping development will become a potent element in American economic growth without the accompaniment of social injury.

The war caused the rapid expansion of our saltwater transportation facilities and yet, even in 1919, only about 34 per cent of our exports and 50 per cent of our imports were moved under the American flag. We must persist in every measure aiming not only to hold, but to increase the proportion of overseas trade under our flag. It may prove difficult when the merchant fleet of Europe begins to be rehabilitated.

They, like the industries of Europe, will seek to undersell us and in order to keep our shipmasters in business we will find it necessary to extend every possible encouragement, every reasonable preference, to our own.

Convinced as I am that the Panama Canal has a peculair concern to the people of our central valley, it has long been a matter of profound regret to me that the Canal should not have been made one of the great free highways of American trade, whatever may have been the merits of the exigencies which sustained the denial to American trade of special advantages due to American ships by reason of our construction of the Canal. The time surely will come when we must claim for our own country and for the western continents every rightful privilege that may occur by virtue of this linking of the two great oceans.

The Canal ought to be an interest and unity between all the Americas, and I cannot but feel that the policy of a Democratic administration in administering the Canal has failed sadly in realizing these possibilities. It will be our aim to correct the mistakes of the past and to devise a constructive American program for the future.—*The Nautical Gazette*, Nov. 6, 1920.

DRASTIC SHIPPING POLICY CHANGES EXPECTED.—In view of the Republican landslide at the elections Tuesday, which swept Senator Harding and Governor Coolidge into office by record-breaking majorities, and in addition increased the Republicans' strength in both branches of Congress, well-informed shipping men are certain that drastic changes will occur in the Government's marine policy after next March 4.

The statement by President-Elect Harding to *The Nautical Gazette* in this issue will serve to provide the only indication, for the present at least, of what the Republican policy will be. It is believed highly probable that in place of the present Shipping Board, a Department of Marine may be created.—*The Nautical Gazette*, Nov. 6, 1920.

SCHWAB WANTS NAVY CONTROL OF OUR MERCHANT FLEET.—American ship owners must receive government aid of some sort or our mercantile fleets will be worse than useless, according to Charles M. Schwab, who expressed his views in Washington a few days ago.

Assailing present shipping laws as entirely inadequate if the American merchant marine is to maintain the supremacy gained during the war, Mr. Schwab declared that the United States must intervene if our flag is to be kept on the seas.

"My theory is a novel one," he asserted. "I believe that American mercantile shipping should be operated in conjunction with the navy.

"Americans naturally shy at the word 'subsidy,' but, call it what you will, I think that merchant ships should be under the control of the navy. The government should be able to pay the difference between the cost of wages of American and foreign seamen. With our merchant shipping under the control of the navy it would be possible to press these ships into immediate service in the event of war."

Mr. Schwab spoke of the present Panama Canal tolls and said existing treaties should be amended so that Americans would not be forced to pay higher tolls than British merchants. "As an American citizen I am part owner in the Panama Canal," he declared, "and I cannot see why a British subject should get a more advantageous rate than I."—*The Nautical Gazette*, Nov. 6, 1920.

GERMAN VIEW.—Not only has the agreement between the Harriman group and the Hamburg-American Line for the operation of American tonnage on certain of the former German trade routes been subjected to considerable adverse criticism in this country, but it is also being assailed in certain German circles as detrimental to German shipping interests. It is claimed that the arrangement will result in such an intertwining of German and American shipping interests that the former will never be able to

effect a severance from the latter. Our German contemporary Hansa scoffs at any such suggestion, however, and asserts that all fears are groundless. It terms the agreement beneficial to German interests and in no way detrimental to American shipping.—*The Nautical Gazette*, Nov. 6, 1920.

WORLD'S FIVE LARGEST SHIPS.—Following is a list of the five largest ships of the world.

	Length	Breadth	Depth	Gross Tonnage
Bismarck	912	100	57.1	56,000
Leviathan	907.6	100.3	58.2	54,282
Imperator	882.9	98.3	57.1	52,022
Aquitania	868.7	97	49.7	45,647
Olympic	852.5	92.5	59.5	46,359

—*The Nautical Gazette*, Oct. 16, 1920.

AERONAUTICS

AIRCRAFT RESEARCH.—The future of the air service, whether for military or commercial purposes, depends upon the development of aircraft research. The matter is one in which engineers are primarily concerned, for the great improvement in the details of design and construction of aircraft and the power to weigh ratio of the engine are the direct development of their labors. Progress has hitherto followed along conventional lines, but it is evidently the intention of the technical experts of the Air Ministry to approach the problems from a somewhat different standpoint. As development has gone a long way ahead of research, the latter has much leaway to make up, and it will probably be some few years before any great advance in aircraft is made.

The conference arranged by the Air Ministry held in London last week, served the useful purpose of extracting from the Controller-General of Civil Aviation a full exposition of the present position and immediate needs of civil flying, while others including Lord Montagu, Lord Weir, experts in design, and representatives of various scientific and commercial interests, threw some light on the problem from different angles. Sir E. L. Ellington, in a paper entitled *The Present Position of Aircraft Research and Contemplated Developments*, set before the conference the Air Ministry's program of research and experiment.

He enumerated the following qualities as those required in the perfect aeroplane or seaplane: (1) Reliability. (2) Ease of control. (3) Power to land and get out of most restricted places. (4) Good performance, that is high speed, quick climb and a ceiling sufficient to surmount any obstacles likely to be encountered, or to escape the enemy's attack. (5) Cheapness in construction and maintenance.

Reliability, he said, was popularly supposed to be principally a matter of the engine, since a forced landing was usually ascribed to engine failure. As a matter of fact, the majority of engines now in use can be relied upon to stand up for a flight of the duration of the fuel capacity of the machine provided the engine is overhauled at the necessary intervals and care is taken to see that it is in thorough working order before starting. The majority of failures which occur are due to failures of accessories outside the engine itself, such as the petrol supply, lubrication, ignition or water systems.

Sir E. L. Ellington announced that besides endeavoring to obtain improvements in existing engines and in new designs of engines of the normal aero engine types, with a view to improving their life and reliability, the Air Ministry were developing two engines which are quite different from the normal aeronautical engine. The first is a swash plate engine, that is, one in which an inclined disc on the shaft takes the place of the crank in the ordinary engine. Such engines have been used for steering gear in sub-

marine work, and an engine for aeronautical purposes of this type shows considerable promise. It is expected that such an engine of a given weight will develop considerably greater horsepower than one of the usual form, either rotary, radial, Vee or straight, or, conversely, an engine of a given horsepower should be designed for a lower weight.

The advantages of such an engine are that a small proportion of the total weight of a machine will be absorbed in the power unit, and, since the cylinders will lie parallel to the shaft, the shape of the engine will enable the fuselage or nacelle containing it to be so designed as to give a reduced head resistance.

The second engine is a steam turbine; it is generally believed that there is a limit in the size of the cylinders which can be used in the ordinary petrol engine, and that this limit is probably somewhere about 100 horsepower for aero engines. It is also obviously desirable not to increase the number of the cylinders largely, on account of the complication of the design. The British engine with the largest number of cylinders now under construction is the Napier Cup with 16 cylinders, and designed to give 1000 horsepower. If larger engines than this are required for aeronautical purposes, and it seems probable that they will be required, a different type of engine is desirable. The steam turbine seems worth experimenting with. So far, the solutions of all the problems of a steam aero engine have not been found, the main difficulty being the design of an efficient condenser within permissible weights. It is proposed to do away with external ignition altogether, and we understand that the Air Ministry are investigating an engine designed on the Diesel principle which will, of course, render this possible.

It is obvious that aircraft must be easily controlled by the pilot, and that the system and apparatus of control must not throw an undue strain on the physical or mental capacity of the pilot. As long as the machines were small, the problem presented no very great difficulties, but with the advent of the big twin engine machines, and the further development of machines with four or more engines, the demands on the strength of the pilot when moving the large control surfaces through long leads began to approach the physical limit of the ordinary man. The number of engine controls to be worked by the pilot, and the complication of the petrol supply put a very severe strain on the mental capacity of the pilot. In order to reduce the physical effort required by the pilot, control surfaces are balanced, and Sir E. L. Ellington stated that the authorities were endeavoring to reduce the friction in the long leads which actuate them in various ways. Mechanical means of moving the control surfaces are also being developed. For some years now large boat seaplanes have been provided with servomotors for this purpose, and apparatus is being developed at the Royal Aircraft Establishment for automatic mechanical control of machines, both longitudinally and laterally, where use is made of a gyroscope.

Connected with the matter of control of machines is the accessibility of the engines during flight. The advantage of having the engine or engines contained in a central engine-room where they are under the supervision of a mechanic during flight is obvious; the disadvantage that such an arrangement necessitates the driving of the propellers through gears and shafting is equally obvious. In order to investigate this problem, three machines are now under construction or consideration. The first, a boat seaplane, where two propellers in the wings are each driven through gearing and shafts by two engines geared together in the hull. The second is a machine where four engines, all geared together, drive two propellers through gearing and shafts. In this case, one or more engines can be cut out for repair or adjustment, and the remaining engines will all continue to supply power to both propellers. In the third, which is only in the design stage, one or two engines contained in the fuselage drive two propellers in the wings. In such machines the pilot will be relieved of control

of the engines, and will signal his orders to the engine-room by means of a telegraph, in the same way as is done on board ship.

In connection with the case of control, the importance of natural stability becomes apparent. Opinions differ as regards its advantage in fighting machines where great maneuverability is required, but for civil machines there can be no doubt of its importance. In the light of knowledge recently gained, the design of a machine with good natural stability presents no very great difficulty.

CONSTRUCTION AND MAINTENANCE.—In discussing cheapness of construction and maintenance, Sir E. L. Ellington referred to the all-metal machine. Towards the end of the war, he said, the Germans produced an all-metal monoplane with planes of deep section. This enabled the cantilever system to be employed, and all external bracing wires or members to be dispensed with. Corrugated metal sheeting takes the place of fabric in the wing and fuselage coverings. Since the Armistice, a civil passenger carrying machine has been developed by Junker from this which appears to have been most successful in Germany and the U. S. A. Such a machine should require little adjustment, and should not deteriorate from exposure to the weather, though its behavior when exposed to the wide range of temperatures met with in the East requires investigation. Several designers in this country are studying similar designs. If it is found possible to introduce into planes so constructed, elements which can be adjusted in flight at the will of the pilot so as to enable a heavily-loaded machine to rise from a confined aerodrome, and land at a low speed while maintaining a high speed in the air, a very great step will have been made in the development of the aeroplane. In the Junker machine, the engine is contained in the fuselage, following normal practice in this respect. A machine is now being designed in this country in accordance with the Voyewodski patents, in which the depth and structure of the wings is such that engines can be installed within the wing structure. Such model tests as have so far been carried out tend to show as might be expected, that aerodynamically there are great advantage in such a design. It is further suggested that the undercarriage should draw up in flight within the main structure of the machine. Should this prove practicable, we shall be approaching finality in the matter of reduction of resistance in a machine driven by an airscrew.

Another development which aims at increasing the efficiency of aircraft is forced induction for the engine combined with a propeller with adjustable blades. As an aeroplane ascends, the air in which it is moving becomes rarefied, and the volume of oxygen taken into the cylinders at each stroke decreases with a consequent decrease in the power developed during the stroke. By means of forced induction, a greater quantity of air and therefore of oxygen is forced into the cylinders than that which would be forced in by atmospheric pressure. The most promising method of doing this appears to be by means of a fan worked by an exhaust turbine, but so far no turbine has been constructed which will not be burnt by the hot exhaust gases. In this connection it should be pointed out that forced induction is useless without a variable pitch propeller, for by forced induction the engine is made to give out the same horsepower at a height as in the dense atmosphere on the ground, but the propeller which near the ground is working efficiently will require a much greater pitch to work with equal efficiency in the rarefied atmosphere at a height, and conversely. Thus it will be seen that the pitch of a propeller should be different at the various engine and aeroplane speeds if the maximum efficiency of the engine and propeller is to be obtained. If, further, the variable pitch propeller is developed to the point where the blades can be completely reversed, the pilot will be provided with an efficient air brake to assist him

in reducing the speed of landing and pulling up after landing has been effected.

In order to remove the possibility of accidents, mechanical means of starting aero-engines are being developed. These generally are of two kinds:

(1) The starter, which is no part of the machine, but aerodrome equipment.

(2) Starting devices which form an integral part of the machine and its engine.

Satisfactory apparatus of the first-class can now be provided, and two patterns have been tried out successfully.

The short survey of the position of aeronautical research placed before the conference by Sir E. L. Ellington should appeal to those whose study is the science of aviation in its widest sense.—*Engineering and Industrial Management*, Oct. 21, 1920.

THE U. S. AIRSHIP "R-38."—The Navy Department announced on September 22 that latest reports from the officers in charge of the construction of the *R-38* at Bedford, England, state the airship will be completed within the next two months. It is not expected that the voyage to the United States will be made before May, 1921. At that time the hangar at Lakehurst, N. J., will be ready to receive the giant dirigible. With the completion of the Lakehurst hangar, the United States will be in the position to construct airships similar to the *R-38*. At the present time the English hangar is the only one in the world in which such a large dirigible could be built. The *R-38* as well as the Lakehurst hangar are the largest of their kind in the world. The latest figures on the *R-38* give the following facts: Length, 694.5 feet; diameter, 85.5 feet; useful lift, 45 tons; fuel capacity, 32 tons (13 tons available for freight personnel, etc.); consumption per hour, 180 gallons; cruising radius, 5600 knots; speed, 60 knots; speed, cruising, 50 knots; complement, 6 officers, 19 men; motors, 6 Sunbeam Cossack, 350-horse-power; gas volume, 22,724,000 cubic feet hydrogen; dead weight, 33 tons.—*The Aerial Age Weekly*, Oct. 18, 1920.

REVISION OF THE COAST OF NEW JERSEY.—In March, 1920, the Army Air Service photographed the coast line of New Jersey from Cape May to Seabright. A single flight was made using the *K-1* camera. The plane flew at an altitude of 10,000 feet, and under very good air conditions. The camera was mounted in gimbals, with a lead weight at the lowest point to assist in maintaining the optical axis of the camera in vertical position. Level bubbles were placed on the camera to aid in keeping the camera in the proper position. This is the most satisfactory way to suspend the camera, and control its verticality, at the present time. The photographs are being used for a revision of the charts of the Coast of New Jersey. The individual photographs are 18 x 24 cm. in size, and the approximate scale is 1:10,000. The photographs are mounted in strip mosaics, for convenience sake, not over four feet in length. The length is generally determined by the position of control points. This composite photograph is compared with the topographic sheet of the same area, and control points identified. The scale of the photographic mosaic is determined, and by means of the pantograph, the data are reduced to the scale of the chart, and transferred from the photographs to tracing paper.

The photographing of this 120 miles of coast line took less than two hours time in an aeroplane. The development of the films and printing took two days time of one man. Two rolls of film were used, a total of 183 photographs. The work of interpreting the photographs, assembling mosaics, comparison with topographic sheets, and reduction to the scale of the chart of the outside shore line required 15 days of office work by one engineer.—*Flying*, November.

NAVY AIRSHIPS CRUISED NEARLY 13,000 MILES.—Following the extended account in a New York newspaper of October 23 of the cruise of a squadron of six U. S. N. airships of the Atlantic fleet air force, the navy news bureau at Washington on October 26 followed with an account of the cruise, which began at Philadelphia, the squadron's home station, on November 12, 1919, continuing until June 28, 1920, the object being to test the seaworthiness of the ships. The squadron was in command of Lieut. Commander Bruce G. Leighton, U. S. N., with Lieut. J. H. Hawkins, U. S. N. R. F., second in command. It first cruised down the Atlantic coast to Hampton Roads, and from there to New York City, where the squadron was reinforced by the U. S. S. *Sandpiper*, which was sent ahead of the squadron, towing a lighter, to take care of the ships on their arrival at the different ports of call on the itinerary. The U. S. S. *Shawmut* accompanied the U. S. S. *Sandpiper* as a tender for the squadron. The ports of call included Charleston, S. C.; Savannah, Ga.; Key West, Pensacola, Tampa, Fla.; Guantanamo, Cuba; Cape Haitien, Mole St. Nicholas, Samana Bay, Haiti; Sanchez, San Domingo; San Juan, Ponce and Miraflores, Porto Rico; St. Thomas, Virgin Islands; Kingston, Jamaica; Nuevitas, Cuba; Turtle Harbor, Fernandina, Southport, Fla.; St. Mary's, Ga.; thence to Hampton Roads and back to Philadelphia. During the entire trip the squadron sailed under its own power and covered a distance of 12,731 nautical miles.—*The Aerial Age Weekly*, Oct. 18, 1920.

SIXTEEN SEAPLANES TO COOPERATE WITH ATLANTIC-PACIFIC FLEET—MANEUVERS ON CHILEAN COAST.—Thirty-eight warships and a fleet of the 16 *F-5-L* type seaplanes will comprise the Pacific fleet that will sail January 5 for the Central and South American cruise. Interest in the battle maneuvers is intensified by the fact that it was off the coast of Chile that the first sea battle between the German and British patrol squadrons occurred shortly after the outbreak of the war.

Already the fleet air men are looking forward to the time when they will sail south. The best athletes from the Pacific will contest honors with the Atlantic. Christmas holidays will be spent by the fleet in their respective ports, after which they will be in readiness to sail south. It is expected that there will be a number of *NC* planes received on the North Island Station soon, some of which will possibly make the trip south for the joint operations of the fleets.—*The Aerial Age Weekly*, Oct. 18, 1920.

ENGINEERING

ECONOMICAL METHOD OF UTILIZING TIDAL FORCE.—G. Bigourdan suggests a method of utilizing the force of the tides by means of a sort of fixed bell, with the open end downwards, and so arranged as to be gradually filled by the morning tide.

The air located in the bell would thus be compressed, resulting in a force which could be used direct or for raising other water and so creating a useful head. As the tide falls air would be sucked into the bell, and thus suction could also be used for raising water to a head.

This indirect means would permit of transporting and utilizing the force of the tides over a certain distance, vertical or horizontal. It has three advantages as compared with the usual direct and intermittent means: (1) it reduces to a minimum the parts exposed to the destructive action of the sea; (2) it permits the use of natural reservoirs, lakes or ponds, situated at various levels, and which would only require the minimum of expenditure for upkeep; and (3) it obviates the great inconvenience of the intermittent and periodic inequality of the tides. (*Comptes Rendus de l'Académie des Sciences*, July 26, 1920.—*The Technical Review*, Sept. 28, 1920.

A HIGH-SPEED INTERNAL-COMBUSTION ENGINE.—H. R. Ricardo, in a paper before the Gas Explosion Section of the British association, as reported in *Engineering*, gave the results of an extended series of tests on a high-speed engine with varying compressions.

A series of the tests dealt with the efficiencies at various loads and with different compression ratios. The results appear in the table. It will be observed that the efficiency at full load was higher with the higher compression ratio; of additional interest are the tests at partial loads, where the efficiencies at the higher compressions show a smaller drop than when using lower compressions.

RESULTS OF THE TESTS

Per cent of full load	Indicated thermal efficiency	Brake thermal efficiency	Relative efficiency
	Compression ratio 6 : 1		
Per cent	Per cent	Per cent	Per cent
100	34.9	30.7	68.2
80	33.	27.5	64.5
60	31.0	25.6	60.6
50	30.0	23.9	58.6
40	....	21.5	....
	Compression ratio 4 : 1		
100	27.5	23.4	64.6
80	25.8	21.7	60.6
60	23.5	19.0	55.3
50	22.3	17.4	52.4
40	....	15.2	....

Experiments with different fuels proved, as might have been expected, that each fuel had a certain limiting and very defined compression, after which detonation occurred, followed by preignition and loss of power. In certain oils no detonation occurred; violent preignition and an excessive drop in speed were the first indications that the compression had been carried too high. In all the ordinary fuels preignition never occurred until the engine had passed through the detonation phase.

The general conclusions arrived at may be summed up as follows:

1. The limiting compression is controlled by the tendency to detonate, which in turn is governed by the normal rate of burning. If means are employed for slowing down the normal rate of burning, such as the addition of a small quantity of CO_2, much higher compression ratios can be employed. Preignition which controls and limits the compression ratio, is in nearly every case brought about by some local use of temperature due to persistent detonation.

2. For any given fuel the tendency to detonate depends, apart from the compression ratio, upon the form of combustion chamber, the number and position of the igniters, the inlet temperature of the mixture, the strength of the mixture and the degree of turbulence.—*Power*, Oct. 9, 1920.

TESTING WELDS.—The question of testing welds is one that has been considered more or less since welding was known, but especially during the last five years. Its importance has now become very great. There have been many failures in the past, many of them not having been explained and some of them having been very expensive. As in all other developments, welding first received its principal impetus from the practical man. Of late, however, the tendency has been to investigate more carefully and more fully and by means not available to the ordinary welder. This means that scientists of all kinds have been called into consultation and that almost

every conceivable method of test has been suggested in order to determine what methods and materials would make the best welds from a standpoint of security, service and cost.

The welding of steel is frequently considered as not being especially difficult, and it is also sometimes considered that steel is steel and that no different treatment is required in the case of different qualities and varieties of steel. This idea is much less common to-day than it was several years ago, but it is still too prevalent for the good of the art. It is not as well known as it should be that a comparatively small difference in the percentage of carbon in the material being welded makes a very great difference in the results of either a bend or tensile test. If the carbon is 0.12 per cent or less, the material is soft, ductile and yields readily to any strain that may be put on it. Such material is frequently used for tanks and, because of its ductility and comparative freedom from damage by heating, is admirably suited for welding. Structural steel, bar steel and boiler plate contain about 0.15 per cent to 0.25 per cent carbon and have a tensile strength of about 60,000 pounds, while the soft low-carbon material has only about 52,000 to 55,000. Ship plate is required to have a tensile strength of from 58,000 to 68,000 pounds and in the heavier sections requires as high as 0.30 per cent carbon. It has been found by experience that the higher the carbon, the more difficult it is to get a satisfactory weld and the more danger there is of injuring the metal being welded. It is also evident that a weld made with a given welding rod or electrode can have only a given strength. If this strength is greater than that of the material being welded, the tests piece will always break outside of the weld. If, on the other hand, the weld is weaker than the material being welded, the rupture will always take place in the weld. An oxyacetylene weld made with ordinary low-carbon welding wire will have a tensile strength of about 52,000 pounds. This is stronger than soft tank steel and weaker than the other materials mentioned. It is possible to get with alloy steel rods of proper composition a tensile strength in an oxyacetylene weld of about 50,000 pounds. Neither of these materials will weld boiler steel, boiler plate or ship plate, so that the rupture will occur outside the weld when the section of the weld is the same as the section of the piece, and in making tests of welded pieces, it is necessary to know accurately the character of the material being welded.

The method of test to be applied in any given case depends largely on the use to which the welded piece is to be put. If it is to be used in a pressure vessel, I believe that not only should a tensile test be made, but that an alternating-stress test should be used because of the breathing of the tank due to changes of pressure. This latter test should also be applied where the weld is subjected to bending strain. There are no standards at present for weld tests, but it is advisable, wherever possible, to follow those of the A. S. T. M.

The best test, in my opinion, to determine quickly the general character of a weld, is to grind it off level with the surface of the pieces and clamp it on an anvil, with the center of the weld level with the top of the anvil, the bottom of the "V" toward the anvil so that the top of the weld is stretched when the projecting end is struck with a sledge. The blow should not be too heavy, and the number of blows and angle to which the piece bends before cracking are quite a good index of the value of the weld. It is true in this test, as in the tensile tests, that the quality of the material being welded has a great influence on the results. Stiff material throws more of the strain into the weld, while self ductile material will itself take considerable of the bend. In the case of defective welds—that is, those not fused along the "V" or which contain slag or other inclusions—this test will at once develop the defects. If a welded piece were to be used in a place where it might become red hot such as, for instance, in a locomo-

tive fire-box crown sheet, it would be entirely proper to test the welds at a good red heat by clamping them in a heavy vise or on an anvil with the center of the weld about half an inch from the edge of the vise or above the face of the anvil, heating them to a bright orange with the torch and then bending them as before as with a sledge.

If such welds are made in ¼ x 2-inch bar steel, a 90-degree single "V" being used, and they bend to a right angle cold without cracking on the outside, a welder may feel well satisfied with his work.

TESTING RAILS FOR HIDDEN DEFECTS.—There has recently been developed a method for testing rails for hidden defects which was devised by A. M. Waring. It consists of deeply etching a polished surface of the material under test. For instance, a section of a weld might be cut out with a hack-saw machined or filed to a true surface, and polished on various grades of emery paper, ending up with 00 Manning. It is then placed in a warm solution of 25 per cent hydrochloric acid and water for from one-half to an hour. The acid will eat away the defects, making the edges of the material at them taper, so that rather large grooves and pits will be visible where the defects prior to the etching would be only microscopic. The etching test I consider to be of the greatest value in ordinary shop practice where it is desired to find out rapidly and quite accurately the quality of the work done by the different welders.

These rough tests, while satisfactory for determining the general quality of the work, do not answer as a basis for design, and more refined tests must be used as before referred to. I believe that the most important of these are the tensile and alternating-stress tests. The tensile test can be made in any shop provided with the usual tensile testing machine. The alternating-stress test is not as yet standardized even for unwelded material. I am inclined to believe that the machine devised by the Quasi-Arc Company is of considerable value, although it does not give absolute results; that is, it does not give the amount of fiber stress to which the piece is subjected.

A great deal may be learned from the appearance of a weld. It is difficult to describe the appearance of good welds, but after they have been seen a number of times an inspector can readily say whether the operator knows what he is doing. In gas welding, I would not accept a ripple weld in heavy material nor one which was narrower than about 2½ times the thickness of the sheet, because I have never seen a weld having these appearances that was properly made. The appearance in a gas weld of porosities on top indicates that the metal has been overheated, and the same thing is true in an electric weld. Inasmuch as I believe that the serious defects in welds are caused by oxides, it would appear wise in the case of gas welding to use no larger top than is necessary to produce thorough fusion. This means that the catalog speeds of welding are impossible if good welds are desired. The same thing is true of electric welds. The reason is that at the high temperatures of the steel caused by too large a tip or too heavy a current, the metal becomes overheated, and in that condition combines more readily with the oxygen of the air or with any excess oxygen in the torch flame, and produces oxides which are readily dissolved by the melted metal. As the metal cools down, these oxides are rejected in large part and pass to the grain boundaries, as do other impurities, so that it is perfectly natural that material that has been seriously overheated should be more brittle and weaker than the material that has been properly melted. In conclusion, I have found in a number of cases that very great improvements in the quality of the work were made by using regularly the bending test already described and by carefully instructing the welders until they were able to make welds that would meet this test with unfailing regularity.—*Power*, Nov. 2, 1920.

NAVIGATION AND RADIO.

ACOUSTICAL METHOD OF TAKING SOUNDINGS.—Sig. Marti describes the possibility of taking approximate soundings by means of a small charge of explosive immersed under water alongside a ship in motion.

A microphone, also immersed and connected up with the ship, registers the sound of the explosion and its echo due to the reflection from the bed of the sea. The interval of time between the original sound and the echo enables the depth to be computed. It is necessary to take into account the speed of the ship and of the variations in the velocity of sound due to temperature. The temperature correction introduces some uncertainty which can be neglected for small depths but not for greater depths. As, however, the horizontal distribution of temperature is generally uniform over considerable areas in deep water, a few measurements made with the ordinary sounding apparatus would be sufficient to give the temperature correction for a number of soundings taken by the acoustic method. A writer, commenting on the method, states that, while it is not new, the experiments described by the author represent its first practical application, which seem to give good results.

The acoustic method of sounding would probably be very useful for hydrographic surveys such, *e. g.*, as are necessary to determine the course of a submarine cable. (*Bolletino dell' Istituto Oceanografico; Rivista Marittima,* April, 1920.—*The Technical Review;* Sept. 28, 1920.

MAKING SHIPS FOG-PROOF.—As a practical guide to fog-blinded ships, which literally leads them to their berths in New York Harbor, the navy's new radio cable along the Ambrose Channel probably marks a new era in navigation; certainly in its first public demonstration, so soon after its actual laying was completed, it had passed far beyond the experimental, and our readers will be interested in the account of the demonstration on another page of this issue.

In minimizing hazard, insuring quicker docking, and effecting financial economics in operation, the radio cable fill a long-existent need. That navy enterprise can quickly extend these facilities to other ports seems assured, and adequate Congressional aid should be given freely toward this achievement. At the ports of Savannah, Charleston, Jacksonville and New Orleans fogs have caused expensive delays, and at times serious accidents. The radio cable, judged by the demonstration in New York, will make arriving ships accident-proof. And the advantages of American ownership of the advice for possible wartime emergencies should be an added source of pride.—*The Nautical Gazette,* Oct. 16, 1920.

RADIO CONTROL OF NAVAL UNITS.—Down through the long history of naval warfare and particularly during the last fifty years of it, successive inventions have been hailed upon their appearance as being "revolutionary." Armor plate, the rapid-firing rifled gun, the torpedo, the torpedo boat, the submarine and now the airplane, have been quoted as destined to turn everything naval upside-down, and lead overnight to the scrapping of the existing instruments of battle and the substitution in their place of the new wonder. In varying degrees, but in infinitely less measure than was predicted, the successive inventions have modified the art, or rather the instruments, of naval warfare; but not once have they revolutionized it. The student of naval history will find that these predictions have come mainly and almost exclusively from the pen of the layman. Rarely is it that the professional mind leaps to extravagant and over-hasty conclusions of this kind. Occasionally it does, and for proof of it we have only to bear in mind the recent pronouncements of Admirals Sir Percy Scott and Lord Fisher.

Just now we are beginning to hear about the great possibilities of distant radio control of naval weapons which hitherto have required direct manual

control. Experimental work carried on during the war proved that such control is possible, under favorable conditions, to an extent which before the war would have been scouted as quite impossible. Thus, it was shown that an airplane could be loaded with high explosives, sent up into the air without any pilot aboard, and directed by means of a new radio-control system installed on a pilot machine. It was proved that this controlled machine with its high explosive charge could be flown in the desired direction and made to strike unerringly any desired objective.

In other experimental work, carried out, like that to which we have just referred, under government auspices, it was proved that a torpedo may be steered into contact with its objective by means of radial impulses sent from an observing pilot plane flying overhead. Doubtless in the recent bombing of the old battleship *Indiana*, use was made, if not of the same electrical appliances, at least of the same general principle. In this case, the *Indiana*, without a single man aboard, steaming at ten knots was steered through radio control from the U. S. S. *Ohio*, which maintained a distance of about 5 miles from the moving target.

It is too early to predict to what extent radio control can be substituted for manual control in aiming and firing the tremendous weapons which modern invention has placed at our disposal. If, for instance, the course of a torpedo can be controlled from an airplane and further experimental work fulfils the promise that is contained in this new method, we shall come nearer to revolutionary changes than ever before. This efficiency under war conditions, however, has yet to be proved.—*The Scientific American*, Oct. 30, 1920.

RADIO MANEUVERS WARSHIPS.—Experiments just completed by the United States Navy prove that 12,000-and 13,000-ton battleships can be successfully maneuvered by radio from land stations operating directly upon the steering gear at a distance of from four to five miles. Reports of these tests, which were conducted off the Virginia Capes with the battleships *Ohio* and *Iowa*, have been received by Rear Admiral Griffin, chief of the Bureau of Steam Engineering. The experiments will, it is stated, revolutionize all future sea flights, as they prove that unmanned ships loaded with high explosives and fire ships can be directed with unerring accuracy against an enemy fleet.—*Aerial Age Weekly*, Oct. 30, 1920.

THE CORONA VOLTMETER.—An improved form of corona voltmeter is described for voltages of 150,000 volts. The instrument enables the corona to be used as a natural standard of high voltage, and its use has indicated an interesting modification in the law of corona formation.

The voltage at which the corona appears on a clean round rod is found to be constant to within one-tenth to one-quarter per cent. The law connecting the critical or corona-forming voltage gradient E in kilovolts per cm. at the surface of a wire of r cm. radius and the relative density δ of the gas may be stated in the form—

$$E/\delta = A + B/\sqrt{(\delta r)},$$

and when the constants A and B are determined, the voltmeter has a calibration depending only on its dimensions, and so constitutes a natural secondary standard of voltage. The determination of these constants involves the accurate measurement of the crest value of the voltage at which the corona appears, the ascertaining of the corona voltage to as small a difference of voltage as possible, and the measurement of δ. The main body of the article is concerned with the methods devised to make these measurements.

Whereas it was found that E/δ and $1/\sqrt{(\delta r)}$ are connected by a linear relation, in accordance with the formula above, for small rods and low pressures, yet for large rods and high pressures a departure from the straight line appeared. This is explained by the difference in the values of A and B that exist for the positive and negative corona. This is taken

account of by noting that for values of $1/\sqrt{(\delta r)}$ below 2.295, the negative corona appears first, and $A = 29.87$, $B = 9.918$. On the other hand, for values of $1/\sqrt{(\delta r)}$ above 2.295, the positive corona appears first, and $A = 33.03$, $B = 8.541$.

In the above the value of δ is given by $3.92\ p/(273 + t)$, where p is the absolute pressure in cm. of mercury, and t the temperature in degrees Centigrade. A new corona voltmeter is under construction that will have a range up to 400,000 volts. (J. B. Whitehead and T. Isshiki, *American Institute of Electrical Engineers, Journal*, May, 1920.)—*The Technical Review*, Oct. 19, 1920.

NAVY IMPROVES AIR TRANSMITTER EQUIPMENT.—Capt. George W. Steele, Jr., U. S. N., commanding the Air Detachment, U. S. Atlantic fleet, has reported to the Navy Department that the transmitting equipment installed on navy aircraft recently modified to operate on the new standardized wave length, has proved entirely successful under tests. The installation of distant control for ignition system has practically eliminated all ignition noises, both on the trailing antenna for receiving and on the radio compass coil. This reduction of ignition noises permits inter-communication between aircraft in flight for distances up to 10 miles. With the ordinary installation such communication is practically prohibited except when flying in comparatively close formation.—*The Aerial Age Weekly*, Oct. 30, 1920.

MISCELLANEOUS

THE "SUPER-DESTROYER."—The flotilla leader, which is a super-destroyer, is a new type of vessel developed during the recent war. These vessels are used to lead flotillas of destroyers into action. Being larger than destroyers they carry the essential facilities for a flotilla commander. They are better equipped for signaling and range-finding, carry a heavier battery, and a much more efficient radio equipment than a destroyer. They proved themselves to be very useful in the late war, and are now generally recognized as being required by modern organization for destroyer operations. Also, these larger vessels were found necessary for screening battle-cruisers, where the ability to maintain high speed in a seaway is a prime necessity.

The foregoing admirable summary of the functions of the flotilla leader is contained in the recommendations made by the General Board of the United States Navy for the building program of 1921. Five vessels of this type were included in the Board's program, which, however, has not been accepted by Congress, with the result that, for the next few years the United States Navy will have to do without a type of fighting ship which is possessed and highly prized by the other navies of the world. The flotilla leader is really an old type revived under a new name. It is the modern descendant of the "divisional torpedo-boat" and the "torpedo-gunboat" built during the closing decades of the 19th century, types which, in their turn, had sprung from the sea-going torpedo-boat and eventually became merged in the destroyer. The credit of having invented the flotilla leader must go to Germany, who some forty-five years ago ordered the *Zieten*, a fast "torpedo aviso," from the Thames Ironworks of London. Although but 975 tons in displacement and barely 200 feet in length, she had a speed of 16 knots, remarkable for those days, and carried a powerful armament of four 4.7-inch breech-loading guns, with submerged tubes at bow and stern for ejecting the "fish" torpedo. The success of the *Zieten* led others powers to experiment with vessels of this type, from which there grew a very numerous family. It was only in Germany, however, that the original function of the *Zieten* as a leader of torpedo boats was kept steadily in view, though lack of funds prevented that country from perpetuating the type.

In 1906 tactical maneuvers held in the North Sea convinced the British Admiralty that the system of using destroyers in large flotillas of twelve

to twenty boats necessitated the building of special leaders, or flag boats, from which the commodore in command could control his flotilla just as an admiral handles a squadron or fleet of battleships from his flagship. Since the ordinary destroyer did not offer sufficient bridge room, living accommodations, and other facilities for the commodore and his staff, it was considered necessary to design a vessel of larger dimensions, fitted up as a miniature flagship, and possessing superior qualities of speed and armament. The pioneer vessel of this type was the *Swift*, ordered from Cammell-Lairds of Birkenhead, in 1906. She displaced 1825 tons, was 353 feet in length and 34½ feet broad, and was equipped with turbine machinery of 30,000 shaft horsepower to produce the then phenomenal speed of 35 knots, which was at least five knots more than the best British destroyer of the period could make. The trials of this vessel, which was launched in 1907, were watched with keen interest, as few engineers believed she would ever make her contract speed. But the first runs over the measured mile confounded the skeptics, for the best run at full power gave a maximum velocity of 38.3 knots—a world's record which remained unbroken for ten years. Her boilers were exclusively oil-fired, and the success of this innovation encouraged the British Admiralty to embody the liquid fuel system in their later destroyers. But this drawback to the *Swift* was her inordinate cost—£280,500 ($1,402,500 at normal rate of exchange). For this sum three destroyers of ordinary type could be built, and consequently no further leaders were built until 1913, in which year the *Marksman* and *Lightfoot* were laid down. The *Swift* performed most valuable service during the war, and her dashing exploit in April, 1917, when, in company with the *Broke*, she fell upon six German destroyers in the Dover Strait and routed them with heavy loss, will long be remembered. Shortly before that action her original armament of four 4-inch rapid-fire guns had been changed to one 6-inch and two 4-inch, so that she was a most formidable opponent for any destroyer. Various structural modifications have now brought her displacement up to 2207 tons, but she is still good for 35 knots.

The value of the flotilla leader is evidenced by the fact that during the war period every naval belligerent, with exception of the United States, built many vessels of this type. Great Britain added no less than 34 of them to her fleet; Germany laid down flotilla leaders of unprecedented size and power; and both Italy and Japan evolved some very striking designs. The new French naval program includes six 2000-ton leaders, and the U. S. Navy Department is known to have prepared plans for vessels of the same type, though their construction has still to be authorized.

The accompanying table shows at a glance the principal features of representative flotilla leaders built, building, and projected for the world's navies.

TYPICAL FLOTILLA LEADERS OF THE LEADING NAVIES AT A GLANCE

	British		*German*	*Japanese*	*Italian*	
	GRENVILLE	WALLACE	V-116	AKIKAZE	AQUILA	LEONE
Number of boats in class	6	12	12	5	4	4
Year of launch	1916	1918	1917	1921	1916	1920
Length over all, feet	325	329	360	350	315	360
Beam, feet	31¾	31¾	36	34	31	34
Displacement, tons	1,666	1,740	2,400	1,900	1,600	2,200
Shaft horse-power	36,000	40,000	55,000	50,000	44,000	42,000
Speed, knots	34	36	35	38	34	34
Fuel capacity, (oil) tons	500	550	700	600	260	400
Armament: guns	4—4 in. R. F.	5—4.7 in. R. F.	4—5.9 in. R. F.	4 (or 5)—5 in. R. F.	3—6 in. R. F.	8—4.7 in. R. F.
Torpedo tubes	4—21 in.	6—21 in.	4—23.6 in.	6—21 in.	4—18 in.	6—18 in.

It will be seen from the accompanying list that the German flotilla leaders easily surpassed their contemporaries in size and weight of armament. These twelve boats—*S-113-115, V-116-118, G-119-121, B-122-124*—were designed to form an "Iron Division," primarily for the purpose of defending the "Heligoland Bight" against British raiders and mine-layers. They are of peculiar interest, illustrating as they do the radical change induced in the German conception of destroyer functions as the result of war experience. Before the war German naval officers attached minor importance to the gun armament of their torpedo craft. Logically enough, they insisted that the torpedo was the only weapon that counted in this type, and that every ton of available weight must be devoted to speed and torpedo tubes. It was not until a whole series of their boats had been sunk or badly mauled by the heavier gunfire of British destroyers that they departed from this rigid principle. All the German pre-war boats mounted 3.4-inch 22-pounder guns, which were soon replaced by the 4.1-inch 38-pounder with a semi-automatic breech-lock, enabling a very high rate of fire to be maintained. Guns of this caliber were supplied to nearly all the boats built during the war, and proved superior in range and smashing power to the British 4-inch. But it cannot be said that the German destroyers ever took kindly to artillery duels, and to the end of the war they never used their guns to full advantage.

What the big super-leaders of the *V-116* class might have done can only be surmised, for none of them was commissioned in time to take an active part in the war. A great mystery has been made in Germany about these twelve boats and the details of them given in the above list have not previously been published. Five boats were completed in the spring of 1918 and ran their trials in the Baltic. Most of them exceeded the designed speed of 35 knots, but the great weight of armament and the immensely powerful machinery proved too much for the scantlings, and all five had to go into dockyard for extensive alterations, which were still incomplete at the date of the armistice. The four 5.9-inch guns were on high-angle mounts and could be used either for flat trajectory fire or against aircraft. The projectile weighed 101 pounds and contained an exceptionally powerful bursting charge, which would have proved most effective against such comparatively flimsy targets as destroyers. The torpedo armament was limited to four tubes, mounted in pairs amidships, but these fired the new 23.6-inch torpedo, which is the most powerful weapon of its kind in existence. Its warhead is charged with 616 pounds of T. N. T.—practically double the quantity of explosive carried in pre-war torperdoes—and it can travel a distance of 16,350 yards at a velocity of 28 knots. Since it would be impossible to manipulate torpedoes and tubes of this size by hand, the *V-116* and her sister boats had special motors for loading and training the tubes. They were also fitted with the latest appliances for controlling guns, including director aiming and firing mechanism. It is, however, doubtful whether all this cumbersome and intricate gear was suitable for vessels which were simply enlarged destroyers, and therefore exposed to the sort of rough and tumble fighting in which headlong dash counts for more than science. Moreover, experience in other navies shows that the 5.9-inch gun, with its 101-pound projectile, is much too heavy to be conveniently manhandled on the slippery decks of a boat which is moving all ways at once. In theory, the German *V-116* leaders ought to have made short work of any destroyers they were likely to meet in the North Sea; in practice they would probably have been beaten by the smaller British boats armed with the handy 4-inch and 4.7-inch gun.

A particularly formidable type of flotilla leader is represented by the five new Japanese boats of the *Akikaze* class, building under the estimates for the current year. They will displace 1900 tons and have a speed of 38 knots. Four, or possible five, 5.5-inch 82-pounder rapid-fire guns will be mounted on the centerline, and all six torpedo tubes can be trained on either beam. A feature of these boats is their large fuel capacity,

which is expected to give them a cruising radius of 3500 sea miles at economical speed.

It will be seen that the modern flotilla leader approximates to the light cruiser in dimensions and armament. If the recent rate of progress is to be maintained, "boat" will soon become a misnomer, and we shall revert to the "torpedo cruiser" of thirty years ago, though on a much larger scale. In the destroyer and flotilla leader, as in every other type of fighting craft, each new demand for increased armament, speed and sea endurance involves a corresponding increase in size, and there is practically no limit except in the paying power of the nations concerned. But in every class of fighting ship there comes a stage of development which fulfils all reasonable requirements, and beyond which it is unnecessary to go. In the case of the flotilla leader this stage appears to have been reached in the smaller designs set forth in the table shown. War experience has demonstrated the all-round tactical efficiency of such vessels as the British Scott class, which, on the relatively modest displacement of 1740 tons, combine in a high degree the essential qualities of a destroyer flagship. It is of interest to learn that a tentative design prepared at Washington last year provided for a vessel of 1800 to 1900 tons, of 37 knots speed, armed with four 5-inch rapid-fire guns and eight torpedo tubes.—*The Scientific American*, Nov. 6, 1920.

MEDITERRANEAN NAVIES.—The situation in regard to the powers who have naval forces in the Mediterranean is at the present time one of particular interest. In no theater was the outcome of the recent war more dramatic and far-reaching. As regards our own navy, one immediate effect of the armistice was the despatch to the Mediterranean of a squadron of modern battleships, thus restoring a force which we were obliged to withdraw in 1912 owing to the growing menace of the German fleet in the North Sea. In addition to the six *Iron Dukes* there has also been sent to the Mediterranean a light cruiser squadron and a destroyer flotilla, both composed of ships passed into service during the war and a number of attendant vessels, including an aircraft carrier. The Admiralty have stated that this moderately strong force is, in their opinion, necessary to meet political conditions in the Near East. That it is not excessive is shown by the fact that it has been necessary this year to detach a squadron from the main, or Atlantic fleet to the Levant, the Mediterranean fleet being fully employed on other important duties and unable to meet all the demands made upon it. The presence of the battleships under Vice-Admiral Fremantle has given rise to a belief in certain quarters that the Mediterranean is to be regarded in future as one of the principal training grounds of the main fleet, but there is no foundation whatever for this assumption.

Compared with the feverish activity in naval development which was taking place in 1914, the present position is very tranquil. Urged on by her German Allies, Austria had made good progress with her division of four dreadnoughts of which two were in commission. Italy had been obliged to put in hand seven ships of this class, of which three were completed. Against these two partners in the Triple Alliance, France had put afloat thirteen vessels of the dreadnought era, of which eight were complete. The concentration of the whole of the French battleship strength in the Mediterranean, which had the effect of making our Ally superior to the combined fleets of the other two powers, aroused hostile criticism, no less than our own evacuation of those waters and concentration in the North Sea. But the policy in both cases was amply justified by the war, even though, thanks to the commendable attitude of Italy, the situation for the Entente was much better than it might have been. Among the minor naval powers the chief was Turkey, which in addition to her four old battleships and seven small cruisers was having two dreadnoughts built in England; this expansion policy being reflected in Greece, which as an addition

to her armored cruiser and three small battleships, had ordered a battle-cruiser, the *Salamis*, in Germany.

All this has been changed by the war. Austria has disappeared from the list of first-class naval powers, and so far as competition between France and Italy goes, it is a race to reduce their naval commitments rather than otherwise. The Turkish fleet, moreover, has ceased to exist, and Bulgaria is forbidden to develope her forces in the Black Sea. The French Navy thus indisputably holds the first position with 11 modern battleships to the five of Italy. As regards the future, in neither country has a definite program been adopted any more than in Great Britain. Our own action in cancelling the contracts for the *Howe*, *Anson* and *Rodney* has been followed by the French abandoning the construction of the five vessels of the *Bearn* type, which were in a more advanced state, and certain of which are to be used as hulks, and by the Italians stopping all work upon the four ships of the *Caracciolo* type. The only direction in which French naval construction is showing any activity is light cruisers. There is as yet no sign that in either country has naval opinion settled on a new battle-ship type. It will be interesting to see whether the reported intention of Spain to proceed with the building of three 25,000-ton battleships has any influence in inducing the larger powers to follow suit.—*The Army and Navy Gazette*, Oct., 16, 1920.

RAPID TRIMMING OF SUBMARINES BETWEEN TWO STRATA OF WATER.—In considering the possibility of keeping a submarine between two layers of water of different temperature—and, consequently, different density—it is necessary to consider the two factors which must remain the same, viz.: the volume of the submerged submarine and the weight of the water displaced.

To trim the vessel under the circumstances stated above, it is necessary to ascertain its actual volume by deducing the reduction of volume caused by the increased pressure from experiments made during its trials, thus avoiding the dangers due to allowing too small or too great a volume.

The article proceeds to consider the effect of the variation of the temperature of the sea-water—which is stated to be of little importance so far as the volume of the hull is concerned—that of changes in the density of sea-water, and of calm or rough sea effects.

The density of sea-water changes for several reasons, including increase of pressure, the quantity salts in solution, and temperature. The compensating tank of a submarine requires to be not less than 2 per cent of the displacement when in surface trim. Change of buoyancy due to temperature must always be considered if it is desired to effect rapid trimming of the submarine. This can be obtained by measuring the temperature of the sea at different depths by means of a thermometer inserted through the side of the conning-tower, the vessel being maneuvered in depth until a zone of water is reached where the changes of temperature are not very sudden. By making allowance for the variation of temperature when the sea is calm or has recently been so, it is possible so to trim a submarine that she floats with the periscope scarcely showing above water, as if she remained suspended by the periscope. Withdrawing the periscope, she can remain at the particular depth totally submerged, but without diving. (Lieut. Eugenio Normand, Royal Italian Navy (Submarine Section); *Shipbuilding and Shipping Record*, June 3, 1920.)—*The Technical Review*, Oct. 19, 1920.

SECRET SIGNALLING BY INFRA-RED RAYS.—During the war, considerable use was made by the French Navy and Army of a system of lamp signalling in which secrecy was assured by the use of in visible infra-red rays. The signals were detected by the action of the rays on sulphate of zinc which becomes phosphorescent on the application of the rays in certain circumstances.

The source of the rays can be an incandescent lamp in a suitable projector provided with a dark screen which cut off all visible rays. The receiving apparatus is provided with a concentrating mirror and a clockwork device which causes a travelling band coated with the sensitive compound to pass through the focus. The compound is excited by exposure to blue rays obtained from a suitably screened lamp inside the apparatus. The system was used over considerable distances. Another application of the same principle was for detecting the passage of ships across a channel at night. An infra-red beam is directed horizontally across the stretch of water to be watched, and this normally produces a continuous trace in the receiving apparatus except when interrupted by the passage of a vessel when a dark interval is produced. Another method of reception is by means of a delicate thermo-pile and galvanometer. (*L'Ouvrier Moderne*, May, 1920.)—*The Technical Review*, Sept. 28, 1920.

SELENIUM AND SOME OF ITS USES.— Selenium (See, atomic weight 79 2) is most frequently found in the form of selenides of other metals—lead, silver or copper.

Two forms are usually recognized:—(1) Amorphous, (2) vitreous. Commercial selenium is generally vitreous, in small rods of very dark green color. The metallic modification, obtained by heating and annealing the vitreous selenium, is the form most used for electrical applications. The vitreous material is melted and moulded into the required shape, and the temperature allowed to fall to about 210° C., where it is maintained for a few hours, before being allowed to cool slowly to atmospheric temperature. This process has an important effect upon the electrical properties of the material, which in its initial state is practically an insulator, but after annealing becomes a conductor, whose initial resistance depends largely on the annealing process. Its peculiar characteristic is the variation of this resistance with the light falling upon it. As it is now grey and nearly opaque it should be arranged for use in a very thin film.

Amongst its applications one of the first tried was to photometry, but as selenium is variously sensitive to light of different colors the results obtained were inaccurate. The selenium cell has been used in wireless telegraphy and telephony, being connected in series with a battery and telephone receiver, and exposed to light emitted by a searchlight as transmitter, which light can be focussed on to the cell through a lens. Multiplex signalling can be carried on by using color filters, and even the invisible rays of the spectrum can be used. Another application is to the optophone, which enables the blind to read type by sound, the light reflected by or passing through perforations in each letter on to the selenium cells producing a characteristic sound in a telephone receiver. The same instrument can be adapted for locating and recognizing objects in a room.

Selenium is also used for the telegraphic transmission of pictures. It has also given interesting results in the photography of sound waves; by reversing the process of its production a phographic film of such a sound wave may be used to reproduce sound or speech, and it is suggested that the sounds of actors' voices, etc., might in this way be added to the cinema film. (P. R. Coursey, *Wireless World*, May 29, 1920.)—*The Technical Review*, Oct. 19, 1920.

CURRENT NAVAL AND PROFESSIONAL PAPERS*

The War Plans Division, War Department General Staff. *The Journal of the U. S. Artillery*, October, 1920.

Projectiles. *The Journal of the U. S. Artillery*, October, 1920.

Optical Glass and its Future as an American Industry. *The Journal of the Franklin Institute*, October, 1920.

*These articles are kept on file and will be loaned, upon application, to members.

Efficiency of Propulsion of Full-Sized Ships. *The Shipbuilder*, October, 1920.

The Aerial Cruiser (Description of British *R-80*). *The Scientific American*, Oct. 16, 1920.

A Pocket Machine gun (N. Y. Police Force Standard). *The Scientific American*, Oct. 16, 1920.

The Training of Engineering Students in Industrial Management. *Engineering and Industrial Management*, Oct. 14, 1920.

The Future of the Fabricated Ship. *Engineering*, Oct. 8, 1920.

South African Iron and Steel. *Engineering*, Oct. 8, 1920.

The Present Position of Aircraft Research and Contemplated Developments (abstract appears in notes above). *Engineering*, Oct. 15, 1920, *et. seq.*

Dreadnoughts and Dollars. *Sea Power*, November, 1920.

NOTES ON INTERNATIONAL AFFAIRS

FROM OCTOBER 10 TO NOVEMBER 10

PREPARED BY

PROFESSOR ALLAN WESTCOTT, U. S. Naval Academy

POLAND AND RUSSIA

POLISH TROOPS OCCUPY VILNA.—Subsequent to the armistice between Poland and Lithuania, Polish forces under general Zellgouski on October 9 seized and occupied the city of Vilna, the ancient Lithuanian capital. General Zellgouski then announced the existence of a new state of "Central

THE BOUNDARY BETWEEN POLAND AND RUSSIA AGREED UPON AT THE RIGA PEACE CONFERENCE IS INDICATED APPROXIMATELY BY THE DOTTED LINE RUNNING FROM DRISSA SOUTHWARD TO THE RUMANIAN BORDER.
—From November *Times Current History.*

Lithuania," proposed boundary negotiations with the Lithuanian Government at Kovno, and called on Poland for aid and recognition.

This action, analogous to that of d'Annunzio in Fiume, and taken without the open approval of the Polish Government, called forth remonstrances from the western powers. A joint Franco-British note on October 18 summoned Poland to disavow responsibility in the affair. The difficulty was afterward turned over for solution to the commission appointed by the League of Nations which was already on the scene as mediators between Poland and Lithuania. Both these states agreed to continue negotiations under the auspices of the League. On October 28 the League Council meeting at Brussels decided that the territorial dispute between Poland and Lithuania should be settled by a plebiscite.

POLISH-RUSSIAN TREATY RATIFIED.—On October 25 the All-Russian Soviet voted to ratify the preliminary peace treaty between Poland and Russia. Foreign Minister Tchitcherin pointed out that Poland agreed to refuse assistance to Wrangel's forces in South Russia and to deny all other aid to reactionary elements in Russia. This he declared was sufficient to justify the territorial concessions made to the Polish Government

As shown by the accompanying map, the new Russo Polish frontier lies considerably to the eastward of that proposed by the Allied powers, and leaves Soviet Russia with no territory bordering on either Germany or Lithuania.

POLES OBJECT TO DANZIG CONVENTION.—On October 23 the Polish delegates, appearing before the Council of Ambassadors in Paris, presented objections to the Danzig Convention on the ground that it did not give Poland free access to the sea and control of customs, as specified in the Treaty of Versailles. The convention establishes a commission composed half of Poles and half of residents of Danzig, under a neutral chairman, to control the port. The Poles prefer to buy land and develop their own port facilities.

SOVIET NOTE ON SUBMARINES UNSATISFACTORY.—London, November 3.—Replying to the Russian Soviet Government's recent note concerning the operation of submarines by the Soviet Navy, Earl Curzon of Kedleston, Secretary for Foreign Affairs, says the British Government's belief in the proposed aggressive action of the submarines was based on a Soviet Minister's statement when the submarines were launched in the Black Sea that he hoped they would sink Entente vessels.

The British Government, Earl Curzon added, did not feel justified in running any risk, and now had found its fears confirmed by the vague statement of the Soviet note, which would permit of Soviet submarine torpedoing a British ship under the excuse of mistaken identity.

The note asserts that the Soviet forces in the Black Sea are still engaged in acts of open hostility against British interests, and it demands definite assurances.—*N. Y. Times*, April 11, 1920.

LLOYD GEORGE ON BOLSHEVISM.—At the Lord Mayor's Banquet in London on November 9, Premier Lloyd George spoke of the Russian problem as follows: "Bolshevism is a passing phase that cannot survive. It is such an

impossible creed, it is such a ludicrous creed, it is such a crazy creed, it cannot survive but I tell you what may survive—anarchy.

"Bolshevism will pass away. If Russia falls into the hands of anarchy it may be a generation before it is redeemed. It is a dead loss to Europe. It is worse—it is a festering thing which will poison the atmosphere of the world.

"Therefore, in spite of everything, we persevered to try and secure peace. I know the difficulties—thwarted by suspicions on all hands in Russia, in Europe, in Britain; divided purpose in Russia, divided purpose in Europe, and, above all—there is no use pretending—we have been dealing with men who, unfortunately, did not realize how important it is that they should respect their own obligations. In spite of all that we mean to persevere, because we realize the danger of a Russia sunken and sodden in anarchy."

LEAGUE OF NATIONS

MEETING OF LEAGUE ASSEMBLY AT GENEVA.—During the first weeks of November preparations for the first meeting of the League of Nations Assembly at Geneva on November 15 were well under way and delegates were arriving. It was reported that Germany, Austria, and Bulgaria would apply for admission to the League. A program of business to be taken up by the Assembly consisted of 29 items, including election of president, nomination of committees, consideration of amendments to the covenant, consideration of the tribunal plan proposed by the committee at The Hague, and admission of new members to the League.

LEAGUE COUNCIL AT BRUSSELS.—Brussels, October 28 (Associated Press).—The Council of the League of Nations this morning closed its sessions in Brussels. The Council took a final adjournment after referring the question of Danzig, the regulations concerning which are in dispute between Poland and the authorities of the free city, to the Assembly of the League, which is to meet at Geneva next month.

The Council took other important action in deciding upon a plebiscite as to the disposition of the territory in dispute between Poland and Lithuania, this including the line fixed by the Supreme Council in December, 1919.

A. J. Balfour, the British representative, in making the closing address declared that four great powers not now members of the League would enter it shortly.

"Without these great powers," he added, "It is impossible to predict what the League may accomplish."

FRANCE AND GREAT BRITAIN PUBLISH AGREEMENTS.—At the Brussels meeting of the League Council, Great Britain submitted for registration and publication 16 international agreements made with foreign powers or self-governing commonwealths within the British Empire since January 10 last. This action was in compliance with Article XVIII of the League Covenant providing that "no treaty or international engagement shall be binding until registered." The documents included the Anglo-French oil agreement, a commercial agreement with Esthonia, and the contract with Soviet Russia relating to prisoners.

France announced on November 1 that the military treaty between France and Belgium would also be placed on file with the League secretary and published.

OBJECTIONS TO CECIL AS SOUTH AFRICAN DELEGATE.—Prior to the session of the League Assembly at Geneva, Premier Smuts of South Africa named Lord Robert Cecil as one of the two members of the South African delegation. To this nomination France made a formal protest on the ground that delegates from British self-governing commonwealths should be citizens and presidents of those commonwealths and not Englishmen, in order that England should not control six votes in the assembly.

LEAGUE COUNCIL ADOPTS WORLD COURT PLAN.—On October 26 the League Council approved the plan for a permanent court of international justice as proposed by The Hague Committee of Jurists, with the exception of the provision for obligatory jurisdiction and certain other minor matters. The plan for the choice of the judges, and other provisions attributed to Mr. Elihu Root, were adopted in their entirety.

The proposal for compulsory jurisdiction provided that the court should have jurisdiction in any case in which one party in the case appealed to it. To this Norway and Denmark raised objections on the ground that it went further than the League of Nations Covenant itself. They proposed instead that the court should have jurisdiction only in cases in which both parties made appeal.

ALLIED AGREEMENT ON REPARATIONS PLAN

Paris, November 6.—The dispute between the British and French Governments as to whether the Reparations Commission or Allied Premiers shall fix the amount of German reparations has been settled by a compromise, by the terms of which the Reparations Commission shall fix the amount and the Premiers will look it over before it becomes final. Lord Derby, the British Ambassador, took to the Quai d'Orsay late to-day a note from London containing Lloyd George's latest ideas and the French will reply to-night. I gather that the following four steps will be taken.

(1) There will be a conference between allied experts named by the Reparations Commission and German experts which will study the technical aspects of the problem and report to their government. (2) This will be followed by a conference between representatives of the Allied Governments and the German Government, who will consider reparations and report to their governments. (3) The Commission on Reparations to which the Allied Governments will have communicated their views on the results of the two conferences will fix the German debt to the Allies. (4) The chiefs of the Allied Governments will then meet "to make the necessary decisions," including the fixing of guarantees.

It will thus be seen that there is little likelihood of the amount of reparations being fixed before next May by which time, according to the terms of the treaty, the total must be presented to Germany.

Paris, November 6 (Associated Press).—Coolness between the British and French Governments over their divergent views relative to German reparations was dissipated by a note from the British Government delivered at the French Foreign Office personally by the Earl of Derby last night.

It is said at the French Foreign Office that France now approves, not only of a Brussels Conference of Allied and German experts, but also an advisory meeting at Geneva of allied representatives, which she formerly opposed. There is a possibility that Germans will participate in this meeting.

It is understood that the Geneva meeting, whether attended by the Allied Premiers or not, will draw up a basis for action by the Reparations Com-

mission. The decision of the Commission, according to this understanding, will then be submitted to a conference of the Premiers for final action. It is considered probable, it was added, that the German Minister of Finance will attend the Geneva meeting.—*N. Y. Times,* July 11, 1920.

ENGLAND NOT TO CONFISCATE GERMAN PROPERTY.—At the close of October Great Britain renounced the right of confiscating further German property in the United Kingdom, in case Germany should default in payment of reparations. This action was regarded as a measure for the encouragement of trade between England and Germany, assuring Germans against possible loss of property and goods in British hands.

This action was at variance with the policy of France, where confiscation has already in part been carried out. German property in the United States has been largely converted into liquid assets and is now awaiting the disposition of Congress.

NEAR EAST

ALLIED AGREEMENT ON TURKEY.—On November 4 Great Britain, France, and Italy made public an agreement reached among these three powers regarding their respective spheres of influence in the former Turkish Empire. This agreement, though not announced at the time, was reached on August 10, the date of the signing of the Turkish treaty.

The compact assigns spheres of influence, control of railroads, etc., in Asia Minor, and pledges the three powers to give each other diplomatic support in maintaining their positions in "the areas in which their special interests are recognized." France's concessons lie in eastern Asia Minor, Italy's in the southern part of that region. Great Britain's privileges are not stated, but it is understood that she will be given the presidency of the commission controlling the Dardanelles.

DEATH OF KING ALEXANDER OF GREECE.—King Alexander of Greece died on October 25 from the effects of a bite inflicted by a pet monkey. On October 28, Prince Paul, the 19 year old younger brother of Alexander, was proclaimed king, and Admiral P. Coundouriotis was elected regent until the arrival of the new king.

The offer of the throne to Paul was made on the condition that King Constantine and his eldest son Prince George would formally renounce their rights. In his reply to the offer Prince Paul declared that he could not disregard the rights of his father and elder brother, and that his action would be controlled by the will of the Greek people as expressed in the approaching elections.

These elections, postponed till November 14, were a definite conflict between the Venizelos and the Constantine factions in Greece.

FIUME DISCUSSION RENEWED.—Rapallo, Italy, November 9.—The question of Fiume was brought up for discussion to-day by the conference of Italian and Jugoslav delegates being held here for a settlement of the Adriatic problem, although no agreement has yet been reached on the proposal of the Italian delegates that the Istrian frontier be that established

by the Treaty of London. The Italian delegates proposed that the independence of the new State of Fiume be recognized by both countries, but the Serbian delegates, especially Anton Trumbitch, the Jugoslav Foreign Minister, strongly opposed independence for Fiume. They maintained that the port was indispensable to Serbia for economic and commercial reasons, declaring it be their only safe and fit outlet to the sea.—*N. Y. Times*, November 9, 1920.

MEXICO AND LATIN AMERICA

RECOGNITION OF OBREGON GOVERNMENT.—In a formal statement issued on October 29, Secretary of State Colby made public a letter from Roberto V. Pesquera, confidential agent of the Mexican Government, requesting recognition of the present government of Mexico and resumption of official relations with the United States. In his statement Secretary Colby expressed the opinion that Pesquera's letter "offers a basis upon which the preliminaries to recognition can confidently proceed," that the new government of Mexico "had given indication of stability, sincerity, and a creditable sensitiveness to its duties," and that "the last cloud upon the ancient friendship of the two peoples is soon to disappear."

The chief point of conflict between the two governments is the retroactive feature of Article XXVII of the Constitution of 1917, concerning oil and mineral deposits, which foreign interests in Mexico regard as equivalent to confiscation of their property. It is understood that the present Mexican Government will meet the American objections on this point.

BENTON CLAIMS ADJUSTED.—The claims of the British Government resulting from the murder of William S. Benton, a British subject in Mexico, were adjusted by an agreement between the Mexican and the British Governments made public on November 4. By its terms Mexico will pay 20,000 pesos to Benton's widow, who is a Mexican subject, and a pension during her widowhood of 5 pesos a day.

ZAYAS PRESIDENT OF CUBA.—Early returns from the Cuban election of November 2 indicated the victory of Dr. Alfredo Zayas, Coalition candidate for president, over General Jose Gomez, his Liberal opponent.

SECRETARY COLBY ON SOUTH AMERICAN TOUR.—It was announced by President Wilson on November 9 that Secretary of State Bainbridge Colby would visit Brazil, Uruguay and other South American countries to return visits to the United States made by officials of those countries. The date of Secretary Colby's departure was set for the latter part of November.

JAPAN AND UNITED STATES

TREATY NEGOTIATIONS PROGRESSING.—Washington, Nov. 3.—The Japanese situation will not become tense as the result of the adoption of the referendum in California on the alien land ownership directed against the large Japanese colony in that state. It was learned upon high authority to-day that the State Department had anticipated the vote in California

by reaching a tentative agreement with the Japanese Ambassador as to what action should be taken to satisfy the residents of California.

It is understood that Japan is not unwilling to enact a law prohibiting Japanese immigration to the United States, and that in return for this the Japanese now in California will receive full civil and property rights. Such an agreement has been arrived at, it is understood, but, of course, has to be accepted by the Japanese Government before it becomes operative as well as by the United States Senate. It is understood that if Japan agrees to this solution a treaty will be sent to the Senate which will cover this and other matters in dispute.

It is believed that the stage has been reached where both in Washington and in Tokio tentative drafts of the proposed new treaty and of the modified gentlemen's agreement are being prepared, and it is possible that the present situation will continue for some weeks while the two parties are reaching an agreement upon the exact phraseology.—*N. Y. Times,* Nov. 4.

JAPANESE NAVAL APPROPRIATIONS.—In recent debates on the budget in the Japanese parliament sharp attacks were made upon the enlarged naval program, on the ground that these "colossal estimates for armaments" were aimed especially against the United States. To this Premier Hara replied:

As you are aware, Japan is now among the five great powers of the world, and it is important for her to be provided with armaments commensurate with her position in world politics. I feel sure that the present national defense program will excite no misunderstandings abroad, and that Japan will not be credited with any ambitious designs.—*November Times Current History.*

ANGLO-JAPANESE ALLIANCE.—Washington, Nov. 4.—In diplomatic circles the view was expressed to-day that the defeat of the League of Nations clause in the American elections would have a profound reaction on foreign chancelleries, and that one result would probably be to remove any doubt in respect to the renewal of the Anglo-Japanese alliance.

Baron Hayachi, the new Japanese Ambassador in London, already had stated that there had been no disposition in either England or Japan to adopt any other course than the renewal of the alliance, for which he thought, there was more need now than ever.

The subject of the alliance has been informally discussed by British authorities with American officials and it is believed that changes in the terms of the alliance will reflect England's desire to have nothing in the treaty that might possibly create suspicion in the United States, and Japan's willingness that nothing in it might be construed to threaten this country.—*N. Y. Times,* November 3.

REVIEW OF BOOKS

"Escuela Del Buque," Por Juan Rivera, Teniente De Navio De La Marina Cubana.

This book, which was compiled primarily for the use of officers of the Cuban Navy, consists principally of extracts from "The School of the Ship," by Rear Admiral A. W. Grant, U. S. Navy, with numerous amplifications.

It should prove of interest to the naval officers of all Spanish speaking nations, as it is interesting, instructive and comprehensive.

The forces influencing a ship with one propeller are considered in detail in a chapter written by Captain D. Carlos Suanzes of the Spanish Navy. This is followed by a description of the forces affecting a ship with twin propellers. Then follows a chapter describing the various methods of obtaining tactical data.

The handling of ships in formation is taken principally from U. S. Naval Academy Seamanship Department Notes. Formations in relation to gunfire are considered in detail, with illustrations from modern fleet maneuvers and recent naval battles.

Various methods of scouting and searching are taken up, with free quotations from a book by Commander W. S. Pye, U. S. Navy.

For the greater part "Escuela del Buque," as its name implies, deals with handling ship; and the subject is covered thoroughly.

Naval officers interested in the study of Spanish will find "Escuela del Buque" interesting and profitable reading.

M. M.

"A History of Sea Power." By William Oliver Stevens and Allan Westcott. (New York: George H. Doran Company.)

Considered as a narrative only, this book is excellent in a high degree. It is interesting from the first page to the last, full of incidents of many kinds, clear in statement and description, and replete with historical information of an important kind. No other book contains in so small a space so much information about the rise of sea power, and no other book shows that rise so plainly and progressively.

The book starts with "The Beginnings of Navies" as the title and subject of its first chapter, and presents an interesting picture of the vessels and fleets of the Mediterranean, both naval and commercial, that sailed that wonderful inland sea, when "an Egyptian king, some 2000 years before Christ, possessed a fleet of 400 ships." It then discusses the rise of Crete and the Cretan fleets, and the extraordinary civilization they developed. It takes up the Phœnician merchants and navigators next, and shows how they not only transported the products of west Asian manufac-

turers westward over the Mediterranean and brought back metals and other raw materials, but how they spread the west Asian civilization all over the Mediterranean and even beyond its farthest gate. The rise of Carthage, a colony of Phœnicia, naturally followed; and soon came her attainment of the position of the most affluent and powerful state in all that ancient sea, which then was the center of the maritime activity of the world. Assyria then appears upon the scene, and subjugates Phœnicia and controls her fleets. Assyria and Babylon later falling before Persia, Phœnicia became a dependency of Persia, and helped her conquer Egypt. Next came the Athenians, who developed so fine a navy that they defeated the Persians at Salamis, and made possible the unhindered development of Greek culture. Rome came next; and then came bitter wars, called Punic Wars, between her and great Carthage, that finally laid Carthage literally in the dust, and made Rome the mistress of the sea.

After the fall of the Western Roman Empire in 476 B. C., the Eastern Empire, with its capital at Constantinople, stood as the sole bulwark against all the anti-civilization forces of the world for nearly a thousand years, until taken by the Ottoman Turks in 1453. This feat she could not possibly have performed without the possession of paramount sea power, which in turn could not have been paramount without the secret of Greek fire. Then arose the naval and commercial fleets of Venice, that long withstood the Turk, and finally vanquished him at the battle of Lepanto in 1571.

Nearly a century before, Columbus had discovered America. Then Vasco da Gama circumnavigated Africa, and then Magellan's ship, the *Victory*, circumnavigated the entire world. The large sailing ship was soon developed, and with it many appliances of navigation. The Portuguese, Spanish, Dutch and English then entered into a bitter competition for sea mastery, the Portuguese and Spanish going down first and then the Dutch, leaving Great Britain the mistress of the ocean. France arose to dispute the title: the conflict lasted for more than a century, but it was finally settled in favor of the English by Nelson's victory at Trafalgar on October 21, 1815.

The book makes an attractive sketch of the rise of the American mercant marine and navy, and the subsequent rise of the German and Japanese. The rivalry for world power that characterized the closing years of the 19th century and the opening of the 20th, culminating in the World War in 1914, is interestingly described in Chapter XV, which includes the Spanish American War and the Russian Japanese War. The rest of the book, nearly one-third, is a brief naval history of the World War.

In dealing with the book as a narrative, one must give unstinted praise; but when dealing with the lessons which it draws from history and inculcates, one finds himself shaking his head at times, and at times rising from his chair in indignation. For the authors, instead of confining themselves to their avowed rôle of historians in which they are proficient, not only assume the rôle of strategists, but confidently condemn other strategists, like Jellicoe. Their strictures on Jellicoe concern his conduct at the battle of Jutland, where Jellicoe was and they were not; where Jellicoe knew

more of the information on which he had to act than they do now; where Jellicoe found himself equipped with an experience and a training in naval warfare greater than that possessed by the authors of this book, and therefore a greater competency to decide the questions which were presented to him there than they possess. Had Jellicoe acquitted himself as poorly as the authors of this book presume, England would have said so as clearly as she did to Byng and Calder and many another admiral, who failed to "do his utmost." But, while Jellicoe's failure actually to destroy the enemy was bitterly bemoaned by the British public, and while they realized all the advantages of the enemy's destruction which the authors of this book point out, they realized also that, *under the conditions as they were presented to him*, Jellicoe did exactly right. Jellicoe had not been entrusted with the charge of Britain's whole security in order that he might get a laurel wreath like Nelson's, or even in order that he might do some "stunt" to glorify the British Navy. He was given that charge in order that he might protect Great Britain. This he did.

It is a misfortune which the army and navy labor under, that nearly every one, after learning a few phrases such as "damn the torpedo!" "the spirit of Nelson"; the "writings of Mahan"; "Concentration"; "Keep your powder dry," etc., feels adequately equipped for discussing the most intricate questions of strategy, involving the most esoteric points. In this book, this tendency is shown at its maximum in the discussion of the battle of Jutland; but it prevails throughout. We are told in the Preface, for instance, that "the tendency of our modern era of mechanical development has been to forget the value of history," and are thence led through a narrative which is extremely interesting (largely of actual battles) but which makes only the most casual allusion to the most significant single truth in all the history of sea-power, the enormous importance of "mechanical development." This truth is minimized amazingly; and while the importance of powerful guns is tacitly admitted, the whole subject of accuracy is almost ignored. It is true that one sentence says that "reforms in naval gunnery urged by Admiral Sir Percy Scott (a British officer) were taken up"; but no reference whatever is made to the fact that these reforms were rendered possible by the invention of an American naval officer, which was adopted by the U. S. Navy *ten years* ahead of any other navy. Yet it can hardly be denied that it was the accuracy and consequent effectiveness attained by using that invention which led the navies to make the great increase in size of guns which has followed, the consequent great increase in size of ships, and the consequent great increase in the power of sea-power.

A failure to realize adequately in other ways what our country has done for sea-power seems manifest. One instance is an omission, almost complete, of recognition of Admiral Sims's work in getting effective co-operation between the United States and the Allies in the recent war. Another instance is a wholly inadequate appreciation of the unprecedented and brilliant character of Admiral Plunkett's work in France.

Considered strictly as a history, which is all it purports to be, the book is admirable.

B. A. F.

NOTICE

The U. S. Naval Institute was established in 1873, having for its object the advancement of professional and scientific knowledge in the Navy. It is now in its forty-seventh year of existence. The members of the Board of Control cordially invite the co-operation and aid of their brother officers and others interested in the Navy, in furtherance of the aims of the Institute, by the contribution of papers upon subjects of interest to the naval profession, as well as by personal support.

On the subject of membership the Constitution reads as follows:

ARTICLE VII

Sec. 1. The Institute shall consist of regular, life, honorary and associate members.

Sec. 2. Officers of the Navy, Marine Corps, and all civil officers attached to the Naval Service, shall be entitled to become regular or life members without ballot, on payment of dues or fees to the Secretary and Treasurer. Members who resign from the Navy subsequent to joining the Institute will be regarded as belonging to the class described in this Section.

Sec. 3. The Prize Essayist of each year shall be a life member without payment of fee.

Sec. 4. Honorary members shall be selected from distinguished Naval and Military Officers, and from eminent men of learning in civil life. The Secretary of the Navy shall be, *ex officio*, an honorary member. Their number shall not exceed thirty (30). Nominations for honorary members must be favorably reported by the Board of Control. To be declared elected, they must receive the affirmative vote of three-quarters of the members represented at regular or stated meetings, either in person or by proxy.

Sec. 5. Associate members shall be elected from Officers of the Army, Revenue Cutter Service, foreign officers of the Naval and Military professions, and from persons in civil life who may be interested in the purposes of the Institute.

Sec. 6. Those entitled to become associate members may be elected life members, provided that the number not officially connected with the Navy and Marine Corps shall not at any time exceed one hundred (100).

Sec. 7. Associate members and life members, other than those entitled to regular membership, shall be elected as follows: "Nominations shall be made in writing to the Secretary and Treasurer, with the name of the member making them, and such nominations shall be submitted to the Board of Control. The Board of Control will at each regular meeting ballot on the nominations submitted for election, and nominees receiving a majority of the votes of the board membership shall be considered elected to membership in the United States Naval Institute."

Sec. 8. The annual dues for regular and associate members shall be three dollars, all of which shall be for a year's subscription to the UNITED STATES NAVAL INSTITUTE PROCEEDINGS, payable upon joining the Institute, and upon the first day of each succeeding January. The fee for life membership shall be forty dollars, but if any regular or associate member has paid his dues for the year in which he wishes to be transferred to life membership, or has paid his dues for any future year or years, the amount so paid shall be deducted from the fee for life membership.

Sec. 10. Members in arrears more than three years may, at the discretion of the Board of Control, be dropped for non-payment of dues. Membership continues until a member has been dismissed, dropped, or his resignation in writing has been received.

ARTICLE X

Sec. 2. One copy of the PROCEEDINGS, when published, shall be furnished to each regular and associate member (in return for dues paid), to each life member (in return for life membership fee paid), to honorary members, to each corresponding society of the Institute, and to such libraries and periodicals as may be determined upon by the Board of Control.

The PROCEEDINGS are published monthly; subscription for non-members, $3.50; enlisted men, U. S. Navy, $3.00. Single copies, by purchase, 50 cents.

All letters should be addressed U. S. Naval Institute, Annapolis, Md., and all checks, drafts, and money orders should be made payable to the same.

SPECIAL NOTICE

NAVAL INSTITUTE PRIZE ARTICLE, 1921

A prize of two hundred dollars, with a gold medal and a life-membership (unless the author is already a life member) in the Institute, is offered by the Naval Institute for the best original article on any subject pertaining to the naval profession published in the PROCEEDINGS during the current year. The prize will be in addition to the author's compensation paid upon publication of the article.

On the opposite page are given suggested topics. Articles are not limited to these topics and no additional weight will be given an article in awarding the prize because it is written on one of these suggested topics over one written on any subject pertaining to the naval profession.

The following rules will govern this competition:

1. All original articles published in the PROCEEDINGS during 1920 shall be eligible for consideration for the prize.

2. No article received after October 1 will be available for publication in 1920. Articles received subsequent to October 1, if accepted, will be published as soon as practicable thereafter.

3. If, in the opinion of the Board of Control, the best article published during 1920 is not of sufficient merit to be awarded the prize, it may receive "Honorable Mention," or such other distinction as the Board may decide.

4. In case one or more articles receive "Honorable Mention," the writer thereof will receive a minimum prize of seventy-five dollars and a life-membership (unless the author is already a life member) in the Institute, the actual amounts of the awards to be decided by the Board of Control in each case.

5. The method adopted by the Board of Control in selecting the Prize Essay is as follows:

(a) Prior to the January meeting of the Board of Control each member will submit to the Secretary and Treasurer a list of the articles published during the year which, in the opinion of that member, are worthy of consideration for prize. From this a summarized list will be prepared giving titles, names of authors, and number of original lists on which each article appeared.

(b) At the January meeting of the Board of Control this summary will, by discussion, be narrowed down to a second list of not more than ten articles.

(c) Prior to the February meeting of the Board of Control, each member will submit his choice of five articles from the list of ten. These will be summarized as before.

(d) At the February meeting of the Board of Control this final summary will be considered. The Board will then decide by vote which articles shall finally be considered for prize and shall then proceed to determine the relative order of merit.

6. It is requested that all articles be submitted typewritten and in duplicate; articles submitted written in longhand and in single copy will, however, receive equal consideration.

7. In the event of the prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of the gold medal.

By direction of the Board of Control.

H. K. HEWITT,
Commander, U. S. N., Secretary and Treasurer.

TOPICS FOR ARTICLES

Suggested by Request of the Board of Control

"Rebuilding the Navy's Enlisted Personnel, and Reestablishing Its Morale and Spirit After the Serious Slump Caused by too Rapid Demobilization and High Wages in Civil Life."
"The Human Element in the Administration of Discipline."
"A Demobilization Programme for the Future."
"The Mission of the Naval Academy in the Molding of Character."
"Health of Personnel in Relation to Morale."
"Physical Factors in Efficiency."
"The Naval Officer and the Civilian."
"Naval Bases, Their Location, Number and Equipment."
"Military Character."
"The Ability to Handle Men a Necessary Element in the Equipment of a Naval Officer."
"The Relation of Naval Communications to Naval Strategy."
"The Relation of Naval Communications to Naval Tactics."
"The Training of Communication Officers."
"The Organization of a Naval Communication Service."
"The Naval Policy of the United States."
"A Review of the Battle of Jutland with Lessons to be Learned Therefrom."
"Modification in the Design and Armament of Ships to Meet the New Conditions of Aerial and Subsurface Attack."
"Coordination of Surface, Subsurface and Aerial Craft in Naval Warfare."
"Our New Merchant Marine."
"Submarine Warfare, Its History and Possible Development."
"Escort and Defense of Oversea Military Expeditions."
"A Proposed Building Programme for the U. S. Navy, Including an Efficiency Air Service."
"Naval Organization from the Viewpoint of Liaison in Peace and War Between the Navy and the Nation."
"The Ship's Company—Its Training, Discipline and Contentment."
"The Principles of Leadership of Naval Personnel."
"Morale Building."
"The Value of Facility in Exposition—Verbal and Written—for Naval Officers."
"Discipline as Affected by the Human Relation."
"The Value of Pep."
"Navy Spirit—Its Value to the Service and to the Country."
"The Influence of the Term of Enlistment on the Efficiency of the Service."
"The Principles upon which Should be Founded the Freedom of Neutral Shipping on the High Seas."
"The Fighting Fleet of the Future."
"The Future of the Naval Officer's Profession."
"The Navy: Its Past, Present and Future."
"The Navy in Battle: Operations of Air, Surface and Underwater Craft."
"Shall I Remain in the Navy?"
"Psychology and Naval Efficiency."
"The Naval Policy of the United States in the Light of the Peace Treaty."
"Scope of Naval Industrial Activity and the Navy's Relation to Shore Industry."
"The Pacific Theater."
"Was Germany's Coast Impregnable?"
"Future Development of the Naval Shore Establishment."
"America as a Maritime Nation."
"Arguments for and against the Restriction of the Manufacure of Munitions to Government Owned Factories."
"The Present Rule of Neutrality regarding Contraband and Blockade—Is it Justifiable in Ethics or in Expediency?"
"The United States Navy and the League of Nations."
"Is a League of Nations *Navy* Desirable?"
"The Adaptability of Oil Engines to all Classes of War Vessels."
"The Place of Mines in Future Naval Warfare and the Rules under which Their Use Should be Allowed."
"The Use and Abuse of the Doctrine of Continuous Voyage."
"The Question of the Future Use of Submarines."

INDEX TO VOLUME 46

Acoustic Aids to Navigation. Commander C. S. McDowell, U. S. Navy. No. **204,** p. 231.

Accuracy of Fire at Long Range. Captain J. V. Chase, U. S. Navy. No. **210,** p. 1175.

Admiral Nearchos. Captain C. Q. Wright (Ch. C.), U. S. Navy. No. **214,** p. 1925.

Ainsworth, W. L., Lieut. Commander, U. S. Navy. U. S. Naval Ordnance Plant, Charlestown, W. Va. No. **204,** p. 237.

Air Detachment, The Commander D. E. Cummings, U. S. Navy. No. **208,** p. 891.

Alden, C. S. Professor of English, U. S. Naval Academy. American Submarine Operations in the War. No. **208,** p. 811; No. **209,** p. 1013.

Altitude and Azimuth Tables, The use of, for Obtaining Line of Position, Identification of Stars and Great Circle Course. Abner B. Clements. No. **206,** p. 555.

American Production of Military High Explosives and Their Raw Materials. Lieut. Commander C. H. Wright, U. S. Navy. No. **212,** p. 1561.

American Submarine Operations in the War. C. S. Alden, Professor of English, U. S. Naval Academy. No. **208,** p. 811; No. **209,** p. 1013.

Another "Wrinkle" in Navigation. Commander H. K. Hewitt, U. S. Navy. No. **209,** p. 1075.

Application of the Method of Analyzing the Engineering Performance of Destroyers, An. Lieut. Commander W. H. Osgood, U. S. Navy. No. **210,** p. 1223.

Astronomical Observations Made at Low Altitudes as an Aid to Navigation. George C. Comstock. No. **203,** p. 33.

"Aviation" or "Naval Aviation" Which? Commander D. E. Cummings. No. **204,** p. 177.

Badger, O. C., Lieut. Commander U. S. Navy. The Faults of the Present Scheme of Promotion in the Navy and an Attempt at Solving the Problem. No. **207,** p. 719.

Baxter, James P., 3d. Our First National Shipping Policy. No. **210,** p. 1251.

Beach, Edward L., Captain, U. S. Navy. Manila Bay in 1898. No. **206,** p. 587.

Bieg, V. N., Lieut Commander, U. S. Navy. War and Naval Engineering. No. **206,** p. 539.

Blandy, W. H. P., Lieut. Commander, U. S. Navy. Director Fire a Century Ago. No. **209**, p. 1089.

Boresighting Submarine Torpedo Tubes. Lieut. Commander Donald Royce, U. S. Navy. No. **208**, p. 873.

British Blockade and American Precedent, The. Julius W. Pratt. No. **213**, p. 1789.

Brown, S. J., Commodore (Math. C.), U. S. Navy. Method of Gun Construction by Radial Expansion. No. **214**, p. 1941.

Building the Navy's Enlisted Personnel and Reestablishing Its Morale and Spirit. Lieut. Commander J. C. Thom, U. S. Navy. No. **212**, p. 1627.

Bureau of Navigation, Report and Recommendations of a Board Appointed by the Bureau Regarding the Instruction and Training of Line Officers. No. **210**, p. 1265.

Carter, A. F., Commander, U. S. Navy. The Functions of the Office of Naval Operations. No. **204**, p. 169.

Castex, R., Commander, French Navy. Functions of the Office of Naval Operations. No. **214**, p. 1987.

Chase, J. V., Captain. Accuracy of Fire at Long Range. No. **210**, p. 1175.

Clarke, R. R., Lieutenant (C. C.), U. S. Navy. The Construction and Repair Department Afloat, Records of Work and the Hull Book. No. **211**, p. 1465.

Clements, A. B. Forty Years After. No. **203**, p. 87.

—— Line of Position by Azimuth Observations. No. **212**, p. 1637.

Clements, Abner B. The Use of Altitude and Azimuth Tables for Obtaining Lines of Position, Identification of Stars and Great Circle Course. No. **206**, p. 555.

Comstock, George C. Astronomical Observations Made at Low Altitudes as an Aid to Navigation. No. **203**, p. 33.

Construction and Repair Department Afloat, Records of Work and the Hull Book, The. Lieut. R. R. Clarke (C. C.), U. S. Navy. No. **211**, p. 1465.

Copeland, D. Graham. Steel Tower Construction at the World's Greatest Radio Station. No. **214**, p. 1903.

Cotten, Lyman A., Captain, U. S. Navy. That Reminds Me. No. **207**, p. 743.

Craven, F. S., Lieut. Commander, U. S. Navy. The Rôle of the Line. No. **213**, p. 1771.

Craven, T. T., Captain, U. S. Navy. Naval Aviation. No. **204**, p. 181.

Cummings, D. E., Commander. "Aviation" or "Naval Aviation" Which? No. **204**, p. 177.

—— The Air Detachment. No. **208**, p. 891.

Davis, H. F. D., Lieut. Commander, U. S. Navy. What is the Matter with Operating Engineering? The Question. No. **211**, p. 1431.

Destroyer Construction, A Record in. Captain Henry Williams (C. C.), U. S. Navy. No. **206**, p. 531.

Did the *Cyclops* Turn Turtle? Lieut. Commander M. S. Tisdale, U. S. Navy. No. **203**, p. 55.

Dillingham, A. C., Rear Admiral, U. S. Navy. Our Divided Personnel. No. **214**, p. 1921.

Director Fire a Century Ago. Lieut. Commander W. H. P. Blandy, U. S. Navy. No. **209**, p. 1089.

Discipline. By Captain F. B. Upham, U. S. Navy. No. **203**, p. 1.

Discussion: Did the *Cyclops* Turn Turtle? (Lieut. Commander M. S. Tisdale, U. S. Navy.) No. **203**, p. 55.

Discussion by Commander I. I. Yates, U. S. Navy. No. **206**, p. 603.

——— Navy Yard Administration as a Problem in Industrial Management. (Commander James Reed, U. S. Navy.) No. **206**, p. 509.

Discussion by Commander M. G. Cook, U. S. Navy. No. **208**, p. 910.

——— Navy Yard Administration as a Problem in Industrial Engineering. (Commander James Reed, U. S. Navy.) No. **206**, p. 509.

Discussion by Captain A. W. Johnson, U. S. Navy. No. **208**, p. 904.

——— Navy Yard Administration as a Problem in Industrial Management. (Commander James Reed, U. S. Navy.) No. **206**, p. 509.

Discussion by Captain E. L. Beach, U. S. Navy. No. **208**, p. 903.

——— Navy Yard Administration as a Problem in Industrial Engineering. (Commander James Reed, U. S. Navy.) No. **206**, p. 509.

Discussion by Captain E. P. Jessop, U. S. Navy. No. **209**, p. 1097.

——— Director Fire a Century Ago. (Lieut. Commander W. H. P. Blandy, U. S. Navy. No. **209**, p. 1089.

Discussion by Rear Admiral B. A. Fiske, U. S. Navy. No. **211**, p. 1485.

——— On the Importance of Leadership. (Captain D. W. Knox, U. S. Navy.) No. **205**, p. 335.

Discussion by Rear Admiral Caspar F. Goodrich, U. S. Navy. No. **212**, p. 1645.

——— Accuracy of Fire at Long Range. (Captain J. V. Chase, U. S. Navy.) No. **210**, p. 1175.

Discussion by Captain W. P. Cronan, U. S. Navy. No. **213**, p. 1811.

——— What is the matter with Operating Engineering? (Lieut. Commander H. F. D. Davis, U. S. Navy.) No. **211**, p. 1431.

Discussion by Lieut. Commander R. R. Smith, U. S. Navy. No. **214**, p. 2001.

Disposition to be made of Neutral Vessels and Their Cargoes which may in Time of War be Seized and Sent in to an Advanced Base. Commander Raymond Stone, U. S. Navy. No. **206**, p. 565.

Dyer, George P., Commander (S. C.), U. S. Navy. Ship's Spirit. No. **204**, p. 253.

——— A Navy Supply Department in War Time. No. **205**, p. 379.

Elements of Leadership, The. Captain D. W. Knox, U. S. Navy. No. **214**, p. 1883.

Faults of the Present Scheme of Promotion in the Navy and an Attempt at Solving the Problem, The. Lieut. Commander O. C. Badger, U. S. Navy. No. **207**, p. 719.

Fay, Richard D. Graphical Method for Reducing Latitude Sights to Meridian. No. **214**, p. 1971.

Feld, R. J., Seaman, U. S. Navy. A Trip Through the Panama Canal. No. **205**, p. 405.

Fisher, J. O., Commander, U. S. Navy. A Rational Amendment to Present Methods of Promotion and Elimination. No. **208**, p. 857.

Fiske, Bradley A., Rear Admiral, U. S. Navy. Invention in War. No. **209**, p. 1007.

Forms of Government in Relation to Their Efficiency for War. Rear Admiral A. P. Niblack, U. S. Navy. No. **211**, p. 1399.

Forty Years After. A. B. Clements. No. **203**, p. 87.

Frost, H. H., Lieut. Commander, U. S. Navy. Night Scouting with Listening Devices. No. **211**, p. 1449.

—— The High Sea Fleet at Jutland. No. **213**, p. 1721.

Functions of the Office of Naval Operations, The. Commander A. F. Carter, U. S. Navy. No. **204**, p. 169.

Functions of the Office of Naval Operations, by Commander R. Castex, French Navy. No. **214**, p. 1987.

Gill, C. C., Commander. Policy—Its Relation to War and its Bearing upon Preparation for War. No. **212**, p. 1609.

Graphical Method for Reducing Latitude Sights to Meridian. Richard D. Fay. No. **214**, p. 1971.

Greenlee, H. R., Commander, U. S. Navy. Short Range Battle Practice for the Engineers of the Navy. No. **211**, p. 1443.

Gunn, Sidney. The Naval Academy Collection of Paintings. No. **204**, p. 245.

—— The Influence of Sea Power on Civilization. No. **206**, p. 579.

Hains, P. H., Lieut. (C. C.), U. S. Navy. How the *Cushing* Saved the *Murray*. No. **212**, p. 1619.

Hauling 'Em Off Before Dinner. Captain R. Drace White, U. S. Navy. No. **209**, p. 1079.

Heim, S. F. Lieut. Commander, U. S. Navy. An Improved Towing Spar Which Can be Used as a Navigational Instrument. No. **205**, p. 375.

Henning, E. R. Lieut. Rebuilding the Navy's Enlisted Personnel. No. **214**, p. 1979.

Hermance, Carl H., Lieut. Commander, U. S. N. R. F. Rules for the Calculation of Tonnage and Their History. No. **205**, p. 409.

Hewitt, H. K., Commander, U. S. Navy. Another "Wrinkle" in Navigation. No. **209**, p. 1075.

High Sea Fleet at Jutland, The. Lieut. Commander H. H. Frost, U. S. Navy. No. **213**, p. 1721.
Hinkamp, C. N., Commander, U. S. Navy. Pipe Sweepers. No. **211**, p. 1477.
——— Using An Old Wrinkle. No. **213**, p. 1785.
Hoffman, J. O., Lieut. Commander, U. S. Navy. Tact in Relation to Discipline. No. **210**, p. 1197.
Hooper, S. C., Lieut. Commander, U. S. Navy. Sketch of Present Radio Situation Influence on Tactics and Strategy. No. **210**, p. 1200.
How the *Cushing* Saved the *Murray*. Lieut. P. W. Hains, (C. C.), U. S. Navy. No. **212**, p. 1619

Index, Information: No. **203**, p. 96; No. **204**, p. 264; No. **205**, p. 426; No. **206**, p. 610; No. **207**, p. 750; No. **208**, p. 916; No. **209**, p. 1106; No. **210**, p. 1294; No. **211**, p. 1492; No. **212**, p. 1648; No. **213**, p. 1820; No. **214**, p. 2004.
Invention in War. Rear Admiral Bradley A. Fiske, U. S. Navy. No. **209**, p. 1007.

Jackson, John P., Commander, U. S. Navy. Tides and Tidal Currents in Bays. No. **204**, p. 193.
——— A Short and Simple Method of Finding the Longitude at Sea. No. **207**, p. 739.

Kielhorn, [illegible] V., Lieut., U. S. C. G. A Traverse Diagram. No. **205**, p. 361.
Kirk, A. G., Lieut. Commander, U. S. Navy. New Method of Exterior Ballistic Computation. No. **213**, p. 1777.
Knox, D. W., Captain, U. S. Navy. The Importance of Leadership. No. **205**, p. 335.
——— The Elements of Leadership. No. **214**, p. 1883.

Lavender, R. A., Lieut. Commander, U. S. Navy. Radio Equipment on *NC* Seaplanes. No. **212**, p. 1601.
Leadership, The Importance of. Captain D. W. Knox, U. S. Navy. No. **205**, p. 335.
Line of Position by Azimuth Observations. A. B. Clements. No. **212**, p. 1637.
Luckel, Frank, Lieut. Commander, U. S. Navy. Trans-Pacific Communication. No. **213**, p. 1803.

McDowell, C. S., Commander, U. S. Navy. Acoustic Aids to Navigation. No. **204**, p. 231.
McIntosh, K. C., Lieut. Commander (S. C.), U. S. Navy. When I was on the Old U. S. S. *Biftick*. No. **205**, p. 393.
Malloy, W. E., Lieutenant, U. S. Navy. A Suitable Tomb for John Paul Jones. No. **208**, p. 899.

Manila Bay in 1898. Captain Edward L. Beach, U. S. Navy. No. **206**, p. 587.
Method of Gun Construction by Radial Expansion, Commodore S. J. Brown (Math. C.), U. S. Navy. No. **214**, p. 1941.
Minutes of Special Meeting December 19, 1919. No. **203**, p. 93.
Moral Preparedness. Lieut. Ellery W. Stone, U. S. N. R. F. No. **205**, p. 365.
Morgan, James Morris. The *St. Lawrence* and the *Petrel*. No. **210**, p. 1219.
——— Mysteries of the Sea. No. **212**, p. 1643.
Mysteries of the Sea. James Morris Morgan. No. **212**, p. 1643.

Naval Academy Collection of Paintings, The. Sidney Gunn. No. **204**, p. 245.
Naval Reserve, Its Organization, Administration and Training In Time of Peace, The. C. L. Poor, Captain, U. S. N. R. F. No. **203**, p. 39.
Naval Aviation. Captain T. T. Craven, U. S. Navy. No. **204**, p. 181.
Navy Yard Administration as a Problem in Industrial Engineering. Commander James Reed, (C. C.), U. S. Navy. No. **206**, p. 509.
A Navy Yard in War Time. Commander I. I. Yates (C. C.), U. S. Navy. No. **207**, p. 713.
New Methods of Exterior Ballistic Computation. Lieut. Commander A. G. Kirk, U. S. Navy. No. **213**, p. 1777.
Niblack, A. P., Rear Admiral, U. S. Navy. Forms of Government in Relation to Their Efficiency for War. No. **211**, p. 1399.
Night Scouting with Listening Devices. Lieut. Commander H. H. Frost, U. S. Navy. No. **211**, p. 1449.
Notes on International Affairs: No. **203**, p. 147; No. **204**, p. 311; No. **205**, p. 487; No. **206**, p. 653; No. **207**, p. 789; No. **208**, p. 985; No. **209**, p. 1154; No. **210**, p. 1369; No. **211**, p. 1540; No. **212**, p. 1696; No. **213**, p. 1863; No. **214**, p. 2041.

Osgood, W. H., Lieut. Commander, U. S. Navy. An Application of the Method of Analyzing the Engineering Performance of Destroyers. No. **210**, p. 1223.
Our Divided Personnel. Rear Admiral, A. C. Dillingham, U. S. Navy. No. **214**, p. 1921.
Our First National Shipping Policy. James P. Baxter, 3d. No. **210**, p. 1251.

Panama Canal, A Trip Through the. R. J. Feld, seaman, U. S. Navy. No. **205**, p. 405.
Pipe Sweepers. Commander C. N. Hinkamp, U. S. Navy. No. **211**, p. 1477.
Policy—Its Relation to War and Its Bearing upon Preparation for War. Commander C. C. Gill, U. S. Navy. No. **212**, p. 1609.
Poor, C. L., Captain, U. S. N. R. F. The Naval Reserve. Its Organization, Administration and Training in Time of Peace. No. **203**, p. 39.

Possibilities of a Trans-Pacific Flight. Commander G. C. Westervelt (C. C.), U. S. Navy, and H. B. Sanford. No. **207**, p. 675.
Poulsen Arc, The. Lieut. Ellery W. Stone, U. S. N. R. F. No. **208**, p. 1049.
Pratt, Julius W. The British Blockade and American Precedent. No. **213**, p. 1789.
Professional Notes: No. **203**, p. 97; No. **204**, p. 265; No. **205**, p. 437; No. **206**, p. 611; No. **207**, p. 751; No. **208**, p. 917; No. **209**, p. 1107; No. **210**, p. 1295; No. **211**, p. 1493; No. **212**, p. 1649; No. **213**, p. 1821; No. **214**, p. 2005.
Proposed System for Stimulating Interest in Operating Engineering, A. Lieut. Commander Frederick C. Sherman, U. S. Navy. No. **211**, p. 1437.

Radio Compasses. J. B. Will, Lieut. Commander, U. S. Navy. No. **208**, p. 851.
Radio Equipment on *NC* Seaplanes. Lieut. Commander R. A. Lavender, U. S. Navy. No. **212**, p. 1601.
Rational Amendment to Present Methods of Promotion and Elimination, A. Commander J. O. Fisher, U. S. Navy. No. **208**, p. 857.
Rebuilding the Navy's Enlisted Personnel. Lieut. E. R. Henning, U. S. Navy. No. **214**, p. 1979.
Report and Recommendations of a Board Appointed by the Bureau of Navigation Regarding the Instruction and Training of Line Officers. No. **210**, p. 1265.
Reed, James, Commander (C. C.), U. S. Navy. Navy Yard Administration as a Problem in Industrial Engineering. No. **206**, p. 509.
Review of Books: No. **203**, pp. 155, 156; No. **204**, pp. 318, 319, 321, 322; No. **205**, p. 495; No. **206**, p. 662; No. **207**, pp. 796, 797; No. **207**, pp. 797, 798; No. **208**, pp. 991, 992, 993; No. **209**, p. 1162; No. **210**, pp. 1381, 1382, 1383; No. **211**, p. 1547; No. **212**, pp. 1706, 1707, 1708; No. **213**, p. 1870.
Role of the Line, The. Lieut. Commander F. S. Craven, U. S. Navy. No. **213**, p. 1771.
Royce, Donald, Lieut. Commander, U. S. Navy. Boresighting Submarine Torpedo Tubes. No. **208**, p. 873.
Rules for the Calculation of Tonnage and Their History. Lieut. Commander Carl H. Hermance, U. S. N. R. F. No. **205**, p. 409.

Schrader, Albert E., Lieut., U. S. Navy. Tide Diagram. No. **206**, p. 577.
Sea Power, The Influence of, on Civilization. Sidney Gunn. No. **206**, p. 579.
Secretary's Notes: No. **203**, p. 95; No. **204**, p. 263; No. **205**, p. 425; No. **206**, p. 609; No. **207**, p. 749; No. **208**, p. 915; No. **209**, p. 1105; No. **210**, p. 1293; No. **211**, p. 1491; No. **212**, p. 1647; No. **213**, p. 1819; No. **214**, p. 2003.
Sherman, Frederick C., Lieut. Commander, U. S. Navy. A Proposed System for Stimulating Interest in Operating Engineering. No. **211**, p. 1437.

Ship's Spirit. Commander George P. Dyer (S. C.), U. S. Navy. No. **204**, p. 253.

A Short and Simple Method of Finding the Longitude at Sea. Commander John P. Jackson, U. S. Navy. No. **207**, p. 739.

Short Range Battle Practice for the Engineers of the Navy. Commander H. R. Greenlee, U. S. Navy. No. **211**, p. 1443.

Sketch of Present Radio Situation Influence on Tactics and Strategy. Lieut. Commander S. C. Hooper, U. S. Navy. No. **210**, p. 1209.

Stecher, J. L., Lieut., U. S. Navy. The Submarine Watch Officer. No. **205**, p. 355.

Steel Tower Construction at the World's Greatest Radio Station. D. Graham Copeland. No. **214**, p. 1903.

Stone, Ellery W., Lieut., U. S. N. R. F. Moral Preparedness. No. **205**, p. 365.

—— The Poulsen Arc. No. **209**, p. 1049.

Stone, Raymond, Commander, U. S. Navy. Disposition to be Made of Neutral Vessels and Their Cargoes which may in Time of War be seized and Sent in to an Advanced Base. No. **206**, p. 565.

St. Lawrence and the *Petrel*, The. James Morris Morgan. No. **210**, p. 1219.

Submarine Watch Officer, The. Lieut. J. L. Stecher, U. S. Navy No. **205**, p. 355.

Suitable Tomb for John Paul Jones, A. Lieut. W. E. Malloy, U. S. Navy. No. **208**, p. 899.

Supply Department, A Navy, in War Time. Commander G. O. Dyer (S. C.), U. S. Navy. No. **205**, p. 379.

Tact in Relation to Discipline. Lieut. Commander J. O. Hoffman, U. S. Navy. No. **210**, p. 1197.

That Reminds Me. Captain Lyman A. Cotten, U. S. Navy. No. **207**, p. 743.

Them Haly-Con Days. Captain F. B. Upham, U. S. Navy. No. **208**, p. 895.

Thom, J. C., Lieut. Commander, U. S. Navy. Building the Navy's Enlisted Personnel and Reestablishing Its Morale and Spirit. No. **212**, p. 1627.

Tide Diagram. Lieut. Albert E. Schrader, U. S. Navy. No. **206**, p. 577.

Tides and Tidal Currents in Bays. John P. Jackson, Commander, U. S. Navy. No. **204**, p. 193.

Tisdale, M. S., Lieut. Commander, U. S. Navy. Did the *Cyclops* Turn Turtle? No. **203**, p. 55.

Towing Spar, An Improved, which can be used as a Navigational Instrument. Lieut. Commander S. F. Heim, U. S. Navy. No. **205**, p. 375.

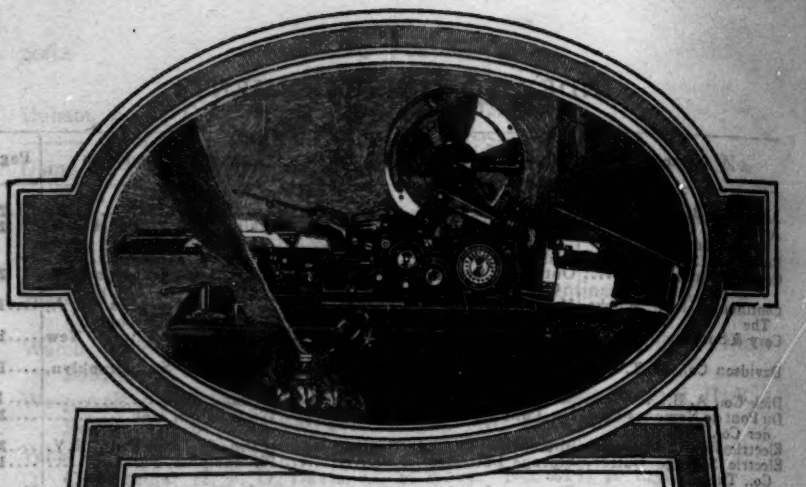
Trans-Pacific Communication. Lieut. Commander Frank Luckel, U. S. Navy. No. **213** p. 1803.

Traverse Diagram, A. Lieut. L. V. Kielhorn, U. S. C. G. No. **205**, p. 361.

Upham, F. B., Captain. Discipline. No. **203**, p. 1.
——— Them Haly-Con Days. No. **208**, p. 895.
Using an Old Wrinkle. Commander C. N. Hinkamp, U. S. Navy. No. **213**, p. 1785.
U. S. Naval Ordance Plant, Charlestown, W. Va. Lieut. Commander W. L. Ainsworth, U. S. Navy. No. **204**, p. 237.
War and Naval Engineering. Lieut. Commander Valentine N. Bieg, U. S. Navy. No. **206**, p. 539.
Watch Officer, The Submarine. Lieut. J. L. Stecher, U. S. Navy. No. **205**, p. 355.
Westervelt, G. C., Commander (C. C.), U. S. Navy, and Sanford, H. B. Possibilities of a Trans-Pacific Flight. No. **207**, p. 675.
What is the Matter with Operating Engineering? The Question. Lieut. Commander H. F. D. Davis, U. S. Navy. No. **211**, p. 1431.
When I Was on the Old U. S. S. *Biftick*. Lieut. Commander K. C. McIntosh (S. C.), U. S. Navy. No. **205**, p. 393.
White, R. Drace, Captain, U. S. Navy. Hauling 'Em Off Before Dinner. No. **209**, p. 1079.
Will, J. B., Commander, U. S. Navy. Radio Compasses. No. **208**, p. 851.
Williams, Henry, Captain (C. C.), U. S. Navy. A Record in Destroyer Construction. No. **206**, p. 531.
Wright, C. H., Lieut. Commander, U. S. Navy. American Production of Military High Explosives and Their Raw Materials. No. **212**, p. 1561.
Wright, C. Q. (Ch. C.), U. S. Navy. Admiral Nearchos. No. **214**, p. 1925.
Yates, I. I., Commander (C. C.), U. S. Navy. A Navy Yard in War Time. No. **207**, p. 713.

INDEX TO ADVERTISEMENTS

Name	Manufacturers of or dealers in	Post office address	Page
American Brass Co., The	Tobin Bronze	Ansonia, Conn	25
Annapolis Banking and Trust Company, The	Bank	Main St. & Church Circle, Annapolis, Md.	25
Bethlehem Steel Co.	Ordnance	South Bethlehem, Pa.	9
Calm, Herman	Outfitter Chief Petty and Warrant Officers	45 Sands St., Brooklyn, N.Y.	23
Continental Iron Works, The	Morison Suspension Furnaces	West and Calyer Sts., N. Y., Borough of Brooklyn	15
Cory & Son, Inc., Chas.	Manufacturers and Designers	183-187 Varick Street, New York, N. Y.	11
Davidson Co., M. T.	Steam Pumps, Pumping Engines, Condensers, Evaporators, etc.	43-53 Keap St., Brooklyn, N. Y.	16
Dick Co., A. B.	Mimeograph	Chicago, Ill.	11
Du Pont de Nemours Powder Co., E. I.	Du Pont Powder	Wilmington, Del.	25
Electric Boat Co.	Submarine Torpedo Boats	11 Pine St., New York, N.Y.	20
Electric Storage Battery Co., The	Storage Batteries	Philadelphia, Pa.	18
Electrose Mfg. Co.	Electrose Insulators	60-82 Washington Street, Brooklyn, N. Y.	2d cover
Farmers National Bank of Annapolis, The	Bank	Annapolis, Md.	23
Ford Instrument Co., Inc.	Scientific Instruments, Automatic Machines, etc.	80 Lafayette St., New York, N. Y.	23
France Packing Co.	Metallic Packings	Tacony, Philadelphia, Pa.	22
General Electric Co.	Complete Electrical Equipment and Supplies	Schenectady, New York	26
Griscom-Russell Co., The	Engineers—Manufacturers	2152 West St. Bldg., New York	18
International Printing Co.	U. S. Marine Corps Score Book	236 Chestnut St., Phila., Pa.	15
Kinney Mfg. Co.	Oil Cargo Pump	3529 Washington St., Boston, Mass.	13
Lidgerwood Mfg. Co.	Hoisting Engines, Winches and Steering Gear	96 Liberty St., New York, N. Y.	15
Loomis-Manning Filter Distributing Co.	Filters	1421 S. 37th Street, Philadelphia, Pa.	23
Lord Baltimore Press, The	Printers and Bookbinders	Greenmount Ave. & Oliver St., Baltimore, Md.	19
Metal and Thermit Corporation	Thermit Process	The Equitable Building, 120 Broadway, New York	14
Morris Machine Works	Builders of Pumps, Dredges, etc.	Baldwinsville, N. Y.	22
Naval Monthly, The	Magazine	207 Bremerton Trust Bldg., Bremerton, Wash.	17
Navy League of the United States	Magazine	1201 Sixteenth St., Washington, D. C.	12
Roelker, H. B.	The Allen Dense Air Ice Machine	41 Maiden Lane, New York	13
Schrader's Son, Inc., A.	Diving Apparatus	783-791 Atlantic Avenue, Brooklyn, N. Y.	21
Schutte & Koerting Co.	Reducing Valves	1104 Thompson St., Philadelphia, Pa.	24
Sellers & Co., Inc., Wm.	Tools, Shafts, Pulleys, etc.	Philadelphia, Pa.	8
Sperry Gyroscope Co., The	Aeronautic Apparatus	Manhattan Bridge Plaza, Brooklyn, N. Y.	16
Sterling Engine Co.	Engines	1262 Niagara St., Buffalo, N. Y.	14
Stratford Oakum Co., George	Oakum	Jersey City, N. J.	22
Underwood Typewriter Co.	Typewriters	1413 New York Ave. N. W., Washington, D. C.	20
U. S. Metallic Packing Co.	Metallic Packings	Philadelphia	24
United States Rubber Co.	Rubber Goods	1790 Broadway, New York, N. Y.	3d cover
Watson & McDaniel Co.	Steam Traps, Reducing Valves, Separators and Other Specialties	128 N. 7th St., Phila., Penna.	20
Westinghouse Electric & Mfg. Co.	Marine Equipment	East Pittsburgh, Pa.	21
York Mfg. Co.	Refrigerating Machinery	York, Pa.	10



It's the *great speed* of the Mimeograph, plus its accuracy, that has made it a vital tool of industry and war. Dictate a message, and within the hour the Mimeograph will print for you five thousand perfect duplicates. Typewriting, handwriting and drawing on the same sheet, and in the one operation. The fineness of its work is equaled only by the simplicity with which it is produced. And the cost is surprisingly small. Investigate! Booklet "F" on request. A. B. Dick Company, Chicago—and New York.

MIMEOGRAPH
EDISON DICK

UNITED STATES NAVAL INSTITUTE PROCEEDINGS

1873-1920

PUBLISHED MONTHLY

EFFECTIVE JANUARY 1, 1920

Annual dues (including subscription) for regular and associate members $3.00, payable upon joining the Institute and upon the first day of each succeeding January. No initiation fee is required.

Subscription to the Proceedings for non-members is $3.50 per annum; enlisted men, U. S. Navy, $3.00 per annum.

Single copies, by purchase, 50 cents.

Postage, at the rate of 50 cents per annum, must be paid on foreign subscriptions.

Subscriptions must be paid for in advance.

Proceedings bound in cloth, $4.00 additional per year, 50 cents of this being for postage.

The Proceedings can be secured through any news agency or direct from the Institute.

Remittances should be made payable to the

SECRETARY AND TREASURER

U. S. NAVAL INSTITUTE

ANNAPOLIS, MARYLAND

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

PUBLICATIONS

U. S. NAVAL INSTITUTE

Publication of books marked with an asterisk (*) has been discontinued. The Institute, however, holds copies which may be obtained until the present edition becomes exhausted.

Catalogue of books published by the Institute containing detailed description and list of contents may be obtained on application to the Secretary and Treasurer, U. S. Naval Institute.

Orders for enlisted men of the army, navy, marine corps and coast guard for books published by the U. S. Naval Institute, will be furnished at a discount of 10 per cent, carriage prepaid.

NAVIGATION

Navigation and Compass Deviations (Revised 1917, with all problems and solutions brought to accord with the new form of the Nautical Almanac).

By Commander W. C. P. Muir, U. S. Navy, formerly Head of Department of Navigation, U. S. Naval Academy. A practical treatise on navigation and nautical astronomy, including the theory of compass deviation, prepared for use as a text-book at the U. S. Naval Academy.

12mo, 765 + xvi pages, illustrated by diagrams and many text figures. Price $3.00. Postage paid.

Elements of Hydrographic Surveying (1911).

By Lieut. Commander George Wood Logan, U. S. N. All branches of the work connected with a marine hydrographic survey as ordinarily carried out have been completely described, and the book is, therefore, available for purposes of reference for naval officers and others who may be engaged in such work.

12mo, 176 pages, full cloth. Price $1.50. Postage paid.

A Practical Manual of the Compass.

7 x 10½ in., 146 pages. Bound in flexible cloth.

MARINE ENGINEERING

Naval Reciprocating Engines and Auxiliary Machinery ("Naval Engines and Machinery").

By Commander John K. Barton, U. S. Navy, Former Head of Department of Marine Engineering and Naval Construction, U. S. Naval Academy. Revised by Comdr. H. O. Stickney, U. S. Navy, recently Head of Department of M. E. and N. C., U. S. Naval Academy.

A text-book for the instruction of midshipmen and for officers preparing for examination, fully illustrated with upwards of 260 text figures, and 48 plates 8 x 10 inches bound separately.

8vo, 619 pages, full cloth. Price $7.50. Postage paid.

Marine and Naval Boilers.

By Lieut. Commander Frank Lyon, U. S. N., and Lieut. Commander A. W. Hinds, U. S. N. Revised in 1915 by Lieutenants W. P. Beehler and John S. Barleon, U. S. Navy, and in 1920 by Commander W. L. Friedell, U. S. Navy, of the Department of M. E. & N. C., U. S. N. A.

This book was prepared in order to provide an up-to-date text-book for the midshipmen at the U. S. Naval Academy. Plates and descriptions include the most modern boiler installations on naval vessels. A study of the book should furnish all the information necessary for the efficient handling of a boiler plant. This book has been revised to December, 1920.

The book is profusely illustrated by text figures and 16 folding plates.

8vo, 404 pages. Bound in full cloth.

Steam Turbines. (Revised 1920.)

A treatise covering U. S. Naval Practice. By Lieut. Comdr. G. J. Meyers, U. S. Navy, of the Department of Marine Engineering and Naval Construction, U. S. Naval Academy.

This book covers turbine installations in the U. S. Navy with chapters on the elementary principles of design and construction. Especially adapted for use of midshipmen and officers of the navy and for an elementary text-book in colleges and universities. It was written to fill the want of a text-book more for the student and operating engineer than for the designer. Illustrated with 165 text figures, 9 plates 11 x 40 inches showing half cross sections of the latest Curtis and Parsons turbines.

Bound in full cloth.

*Experimental Engineering (1911).

8vo, 311 pages, 152 illustrations, cloth. Price $2.15. Postage paid.

Mechanical Processes.

By Lieut. G. W. Danforth, U. S. Navy, Former Instructor in the Department of Marine Engineering and Naval Construction, U. S. Naval Academy.

Giving an account of the materials used in engineering construction and of the essential features in the methods of producing them, also describing shop processes and equipment for the shaping of metals into forms for engineering and general uses.

Effort has been made to present the subject matter in brief and elementary form, with sufficient detail to outline methods and principles clearly. It is intended to show completely, though briefly, the steps of metal manufacture from the ore to the finished product, so that the student may be enabled to classify all branches of metal manufacture, and may pursue intelligently such study as will give fuller information than is possible to include herein.

8vo, 405 pages, 270 illustrations, full cloth.

Handy Book for Enlisted Men of the Engineering Department, U. S. Navy (Third edition, revised, 1918).

The Handy Book for Enlisted Men of the Engineering Department was originally prepared in 1908 by Midshipman Bruce R. Ware, U. S. N., and has been revised and enlarged by Lieutenant Commander A. H. Rice, Jr., U. S. N. The Handy Book is divided into the following parts:

CONTENTS: Part I. Information for all men.—Part II. A: Subjects for examination.—B: Duties and requirements of the various ratings.—Part III. Boilers, coal and oil burning.—Part IV. Marine engines and operations.—Part V. Auxiliary machinery.—Part VI. Piping.—Part VII. Gages.—Part VIII. Internal combustion engines.—Part IX. Some facts of electricity.—Part X. General information.—Part XI. Useful tables of measurements.

278 pages, 119 illustrations, flexible buckram. Price 60 cents, postpaid.

*Engineering Mechanics (1911).

8vo, 326 pages, 2 plates. Bound in full cloth. Price $3.25. Postage paid.

NAVAL CONSTRUCTION

Naval Construction.

By Naval Constructor R. H. M. Robinson, U. S. N. A modern text-book used in the course of naval architecture by midshipmen of the first class, prepared with a view to the special requirements of the U. S. Naval Academy and based upon the practice of the U. S. Navy.

8vo, 285 + VII pages, illustrated by 162 figures and 5 plates. Price $5.00. Postage paid.

The Naval Artificer's Manual, 1918 (Naval Artificer's Hand-Book, 1914, revised).

By Asst. Naval Constructor (T.) McCall Pate, U. S. N., formerly Chief Carpenter, U. S. N.

Appertaining to the care and preservation of the hull and fittings, and the operation of auxiliary machinery on ships of the Navy; containing elementary arithmetic, rules and tables, weights and strength of materials, descriptions of drainage, sanitary and ventilation systems, fire main, flushing systems, steering appliances, telemotors, water-ejecting system, acetylene welding, rules for inspection of lumber, standard formulæ for mixing all kinds of paints used on iron and steel vessels, examination questions pertaining to the various trades of deck artificers, etc.

797 pages, 126 illustrations, stiff buckram. Price $3.00. Postage paid.

SEAMANSHIP

The Watch Officer's Manual (1917).

By the late Ensign C. E. Hovey, U. S. Navy. This manual has been revised to bring it in complete accord with present regulations and methods of watch standing and ship handling. New material has been added to round out the work and make it an indispensable assistant to the present day watch officer.

In flexible cloth, about 90 pages text and 20 pages of colored plates. Price $1.10, postpaid.

Seamanship Department Notes.

Prepared by the Department of Seamanship, U. S. Naval Academy, for use of midshipmen.

Contains notes on the following: Handling Small Boats.—Ground Tackle.—Mooring Alongside the Dock.—Rules of the Road.—Handling Battleships in Formation.—Hints to Young Officers Taking the Deck.—Writing the Deck Log.—Aids to Learning Signals.—Mooring Board.—Duties of a Recorder of a Summary Court Martial.

161 pages, stiff buckram. Price $1.25, postpaid.

Bluejacket's Manual, U. S. Navy (Fifth edition, revised, 1917).

"The Bluejacket's Manual" originally prepared in 1902 by Lieutenant Ridley McLean, U. S. Navy, revised in 1914 to correspond with the provisions of General Order No. 63 of December 16, 1913, and now revised to date by Lieutenant N. R. Van der Veer, U. S. Navy, is issued to the service for the guidance and the instruction of petty officers and enlisted men.

Stiff buckram. Price 75 cents, prepaid.

The Recruit's Handy Book, U. S. Navy (1917).

Flexible buckram cover. Price 20 cents, postpaid.

Routine Book, 1918.

By Captain Reginald R. Belknap, U. S. Navy. A compilation in a concise form of the principles of the organization system applicable to all classes of Naval vessels.

CONTENTS: General Organization.—General Administration.—General Orders.—Honors and Salutes.—Uniform.—Conduct, Liberty, Money.—Delinquencies.—Combination Bill.—Messing Bill.—Berthing Bill.—On Watch in Port.—Duty Bill.—Quarters for Muster and Inspection.—Guard Orders.—Routines.—Cleaning Bill.—Fire Bill.—Collision Bill.—Abandon Ship.—Boat Bill.—Routine Boat Orders.—Man Overboard.—Coaling Bill.—Preparing for Sea.—On Watch at Sea.—Steaming Orders.—Steersmen's General Orders.—Preparing for Harbor.—Water-tight Doors.—Towing Signals.—Docking Bill.—Manning the Rail.—Battalion Bill.—Miscellaneous Notes.—Mess Attendants' Orders.—Ship Handling Notes "A."—Training Course for Signalman and Quartermaster.—Index.—Table Showing Departmental Organization.

578 pages, stiff buckram. Price $2.50. Postage paid.

ELECTRICAL ENGINEERING

Robison's Manual of Radio Telegraphy and Telephony [formerly Manual of Wireless Telegraphy for the Use of Naval Electricians]. (Fifth edition, revised, 1919.)

By Commander S. S. Robison, U. S. Navy. Revised by Captain D. W. Todd, U. S. Navy, and Commander S. C. Hooper, U. S. Navy, in Charge of Radio Division, Bureau of Steam Engineering.

308 pages text, illustrated. Bound in full white canvas. Price $2.50. Postage paid.

Modern Theory and Practice in Radio Communciation, a Text-Book Prepared for the Use of Midshipmen at the United States Naval Academy. (1919.)

By Gordon D. Robinson, M. E., M. S., S. M., Associate Member Institute of Radio Engineers, Instructor, Department of Electrical Engineering and Physics, U. S. Naval Academy, and Paul L. Holland, Lieutenant Commander, U. S. Navy, Instructor, Department of Electrical Engineering and Physics, U. S. Naval Academy.

250 pages text, illustrated, stiff buckram. Price $3.00. Postage paid. When ordering please state the name of the Author.

Naval Electrician's Text-Book. 2 vols. (1917.)

By Captain W. H. G. Bullard, U. S. Navy, completely revised and largely rewritten by officers and instructors of the Department of Electrical Engineering & Physics, June, 1916–July, 1917.

This work was called into existence by the demand of the naval service for a text book which would teach the theory of electrical engineering, stressing such portions as apply particularly to naval practice; the principles governing the operation and use of electrical equipment; and the special knowledge required for the inspection, care and operation of naval electrical apparatus.

Volume I contains the theoretical study of electricity and the principles of electrical engineering. It covers the practice and principles involved in the construction of all direct current and alternating current machines, instruments, devices and apparatus.

Volume II deals with the practical part of naval electrical engineering and contains matter descriptive of generators, motors, distribution systems, auxiliary machinery and miscellaneous apparatus, with principles of operation.

Volume I contains 730 pages, 543 illustrations and an appendix containing standardization rules of the A. I. E. E.

Volume II contains 520 pages and 299 illustrations, including seven large folding diagrams.

Price, bound in full cloth, $4.00 per volume (2 volumes, $8.00), postpaid.

ORDNANCE

Naval Ordnance: Text-Book of Ordnance and Gunnery. Revised Edition, 1915. Corrected to April, 1917.

By Lieut. Commander Roland I. Curtin and Lieut. Commander Thomas L. Johnson, U. S. Navy.

This book has been adopted as a text-book at the U. S. Naval Academy.

8vo, 383 pages, 57 illustrations, bound in full cloth. Price $4.85, postage paid.

The Groundwork of Practical Naval Gunnery, or, Exterior Ballistics. (1914-15.)

By Philip R. Alger, Professor U. S. Navy. Revised and extended to include the formulæ and methods of Colonel James M. Ingalls, U. S. Army, by the officers on duty in the Department of Ordnance and Gunnery, U. S. Naval Academy.

6½ × 10¼ in., 360 pages, bound in full cloth. Price $3.50, postpaid.

Range and Ballistic Tables.

To be used with Exterior Ballistics.

Reprinted for the use of the Midshipmen of the Naval Academy in connection with their course of study in exterior ballistics. They permit problems to be given covering nearly all the guns in most frequent use in the navy at the present time.

12 x 9½ in. (oblong quarto), 95 pages. Bound in full cloth. Four marginal thumb indexes. Price $3.50, postpaid.

INTERNATIONAL LAW

A Manual of International Law for the use of Naval Officers (1917).

By Rear Admiral C. H. Stockton, U. S. N., Retired. Sometime Lecturer upon International Law at the Naval War College, author of "The Laws and Usages of War at Sea: a Naval War Code."

The aim of this work is to present sound and authoritative information based on the historical and accepted policy of our government, as well as the best and most recent European views upon matters of international law.

A supplementary chapter on the new situations which have arisen during the present war and a complete index have been incorporated in this work.

12mo, 340 pages, cloth. Price $2.25. Postage paid.

LANGUAGES

A French Nautical Phrase Book and Reader. Revised, 1919.

By Professor P. Jean des Garennes, Department of Modern Languages, U. S. Naval Academy.

Price $2.00.

A Spanish Nautical Phrase Book and Reader. Revised, 1919.

By Professor Arturo Fernandez, Department of Modern Languages, U. S. Naval Academy.

Price $2.00.

MATHEMATICS

Trigonometry and Stereographic Projections. (Revised, 1919.)

By Professor S. J. Brown, U. S. N. Prepared for the use of midshipmen and adopted as a text-book.

8mo, 203 pages, cloth binding. Price $2.75. Postage paid.

Elementary Mechanics (1920).

This text has been prepared for a short course in mechanics. The attempt has been made to present the fundamental principles of mechanics in a simple manner and to give a rigorous discussion of each topic to the extent that it is treated.

CONTENTS: Vectors, Statics of a Particle, Forces Acting on a Rigid Body, Statics of a Rigid Body, Center of Gravity and Moment of Inertia, Fluid Pressure, Deformable Bodies, Rectilinear Motion, Work and Energy, Curvilinear Motion, Dynamics of a Rigid Body.

330 page and 239 illustrations. Bound in full cloth. Price $7.20. Postage paid.

MISCELLANEOUS

Manual of Athletic Requirements.

By Lieut. Commander W. A. Richardson, U. S. N., Gymnasium Officer, United States Naval Academy.

286 pages, illustrated, paper cover. Price $2.50. Postage paid.

Physiology, First Aid and Naval Hygiene.

By Comdr. R. C. Heiner (M. C.), U. S. N. A text-book for the Department of Naval Hygiene and Physiology at the U. S. Naval Academy, Annapolis, Md.

This book should be made available for the use of all officers and enlisted men. It is highly recommended to Divisional Officers to be used in the general instruction of their men.

12mo, 139 pages. Bound in full cloth, price $1.50. Postage paid.

U. S. Navy Cook Book (Second edition, revised, 1920).

Prepared by the direction of the Bureau of Navigation at the School for Cooks and Bakers, U. S. Naval Training Station, Newport, Rhode Island. All the methods and recipes given have been tried with success at the Cooking School.

130 pages, flexible library duck. Price $1.00. Postage paid.

WM. SELLERS & CO., Incorporated

PHILADELPHIA, PA.

LABOR SAVING MACHINE TOOLS
For Navy Yards, Shipbuilders, etc.

TOOL GRINDERS DRILL GRINDERS

INJECTORS, VALVES, ETC.
For Marine, Stationary and Locomotive Boilers

SHAFTS, PULLEYS, HANGERS, COUPLINGS, ETC
For Economical Power Transmission

For Space and Rates
in our advertising pages
Communicate with the
Secretary and Treasurer
United States Naval Institute
Annapolis - - - - - Md.

Bethlehem Steel Company

BETHLEHEM, PA.

Naval, Field and Coast Defence

GUNS and MOUNTS

Armor Plate Turrets Projectiles

Fuzes Cartridge Cases

Castings Shafting Forgings

Rails Structural Steel

Proving Grounds at

REDINGTON, PA. CAPE MAY, N. J

Manufacturers of Ordnance Material for

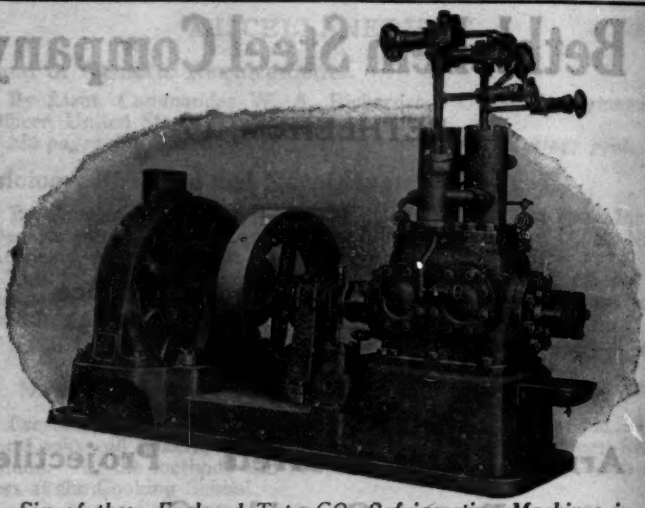
U. S. Navy U. S. Army

and for the Governments of

Great Britain France Russia Italy

Greece Chile Argentina Guatemala

Cuba Spain Etc. Etc.



Six of these Enclosed Type CO_2 Refrigerating Machines in service on the Dreadnaughts "California" and "Tennessee"

Refrigerating Machinery

Following the { Ammonia Compression / Ammonia Absorption / CO_2 Compression } Principles

A Machine to meet every Refrigerating Requirement.

In Capacities ranging from ½-ton refrigerating duty upwards.

Actuated by any available source of power.

Your Refrigerating Machinery Requirements can best be supplied by the Largest Manufacturers of this class of machinery in the world.

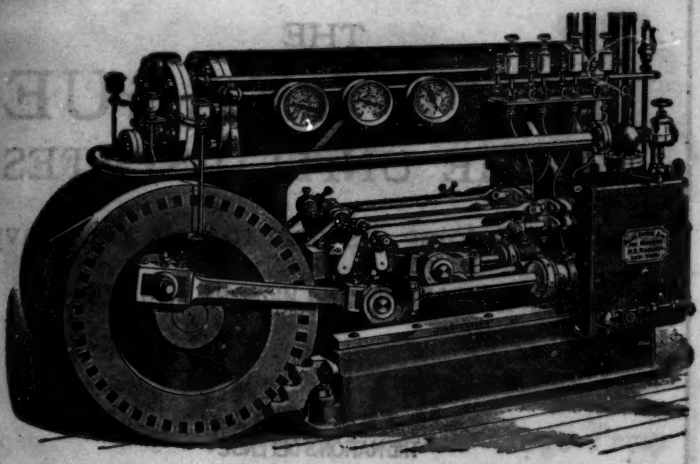
YORK MANUFACTURING CO.

(Ice-Making and Refrigerating Machinery exclusively)

YORK, PA.

Consultation on any Refrigerating Problem invited.

THE ALLEN DENSE AIR ICE MACHINE



Contains only air of 75 lbs. pressure in refrigerating pipes. At about 30 degrees below zero when seawater is at 90 degrees. More than two hundred in use on U. S. Naval vessels. Some since 1888.

H. B. ROELKER, 41 Maiden Lane, New York

CHAS. CORY & SON, Inc.

EST. 1845

NEW YORK 183-187 Varick St. | SEATTLE 515 Hoge Bldg. | PHILADELPHIA 207 Market St. | SAN FRANCISCO 11 Mission St.

Manufacturers and Designers for the U. S. Navy

For more than fifty years

—OF—

Fire Control Systems.

Inter-Communicating Systems.

Ships' Complete Electrical Equipments Built to Meet Naval Specifications.

Originators of Electrical Inter-Communicating Systems for Naval and Merchant Vessels.

Complete Electrical Installations Solicited.

THE

NAVY LEAGUE

OF THE UNITED STATES

Has been doing its part to help the Navy

JOIN THE NAVY LEAGUE AND HELP US WITH OUR TASK

SEA POWER

THE NATION'S DEFENSE

The League's Official Organ

WILL KEEP YOU IN TOUCH WITH OUR WORK

1201 SIXTEENTH STREET, WASHINGTON, D. C.

TEAR OFF AND MAIL THIS COUPON

APPLICATION FOR MEMBERSHIP IN THE NAVY LEAGUE OF THE UNITED STATES

Of the membership fee $1.75 is for a year's subscription to SEA POWER. Subscription to SEA POWER without membership, $3.50.

DUES:

Contributing Member..... $5.00 annually
Life Member..... 100.00 one payment

"SEA POWER," a beautifully illustrated magazine, is sent monthly to all members.

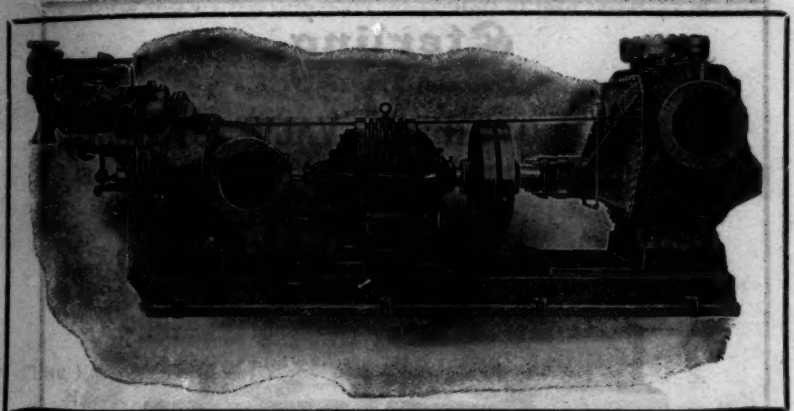
TO THE NAVY LEAGUE,
1201 Sixteenth Street, Washington, D. C.

I am in sympathy with the objects of the Navy League and desire to be enrolled as a.....member. I enclose $.....for fee
(Indicate class of membership)
$1.75 of which is for a year's subscription to SEA POWER.

.....
(Name)

.....
(Address)

N. L. 517 .....



Kinney Steam Jacketed Fuel Oil Cargo Pump

Capacities ranging from 25-4000 gallons

The above cut shows the Kinney steam jacketed pump designed for handling 3,000 gallons of heavy Mexican crude oil per minute. It is driven by a 225 HP, General Electric, Type L turbine with a Fast Turbo Speed Reducer, having a speed reduction of 2400 to 200, and connected to the pump by a flexible coupling. The unit is also controlled by a pressure pump governor set at a predetermined point and operated at the discharge side of the pump.

The pump is also equipped with lantern glands to allow the free circulation of oil through the bearings and back to the suction side of the pump which eliminates all the packing trouble experienced in handling all grades of crude oil.

Two of these units have been furnished for the U. S. S. Tank Steamer "Brazos" built at the Boston Navy Yard and four for Tank Steamers No. 17 and 18 for the same yard.

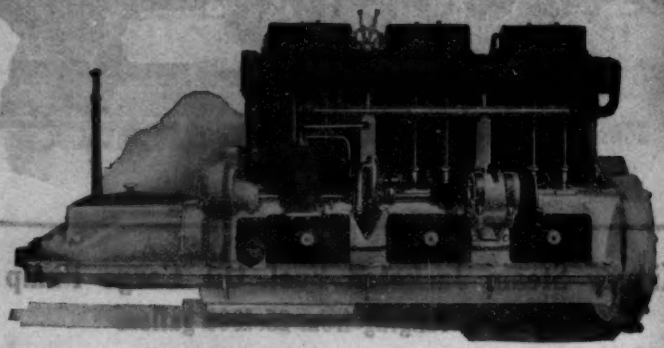
Kinney Manufacturing Co.

Boston, Massachusetts

Sterling
THE ENGINE of REFINEMENT
For the Finest Boats that Float

THE DUAL OVERHEAD VALVE STERLING

In fuel efficiency and power the equal of any gasoline engine in the world



Model GR, 6 cylinders, bore 5¾", stroke 6¾".
4-cyl. motor 150 H. P., 6-cyl. 225 H. P., 8-cyl. 300 H. P.

LITERATURE ON REQUEST

STERLING ENGINE COMPANY

1262 Niagara Street — Buffalo, N. Y., U. S. A.

Thermit Weld on broken Sternframe of the transport "Northern Pacific"

THERMIT WELDING FOR HEAVY MARINE REPAIRS

The only reliable method of welding broken sternposts, rudder frames, crankshafts, connecting rods, and many other heavy steel sections

SEND FOR PAMPHLET 3428

If you are in a hurry, wire or telephone our nearest office

Metal & Thermit Corporation

120 Broadway, New York

PITTSBURGH — SAN FRANCISCO
CHICAGO — TORONTO

The writers only are responsible for the contents of their respective articles

CONTENTS

THE ELEMENTS OF LEADERSHIP. By Captain Dudley W. Knox, U. S. Navy 1883

STEEL TOWER CONSTRUCTION AT THE WORLD'S GREATEST RADIO STATION. By D. Graham Copeland 1903

OUR DIVIDED PERSONNEL. By Rear Admiral A. C. Dillingham, U. S. Navy 1921

ADMIRAL NEARCHOS. By Captain C. Q. Wright (Ch. C.), U. S. Navy. 1925

A METHOD OF GUN CONSTRUCTION BY RADIAL EXPANSION. By Commodore S. J. Brown (Math. C.), U. S. Navy 1941

GRAPHICAL METHOD FOR REDUCING LATITUDE SIGHTS TO MERIDIAN. By Richard D. Fay 1971

REBUILDING THE NAVY'S ENLISTED PERSONNEL. By Lieutenant E. R. Henning, U. S. Navy 1979

FUNCTIONS OF THE OFFICE OF NAVAL OPERATIONS. By Commander R. Castex, French Navy. Translated by Prof. Allan Westcott, U. S. N. A. 1987

DISCUSSION 2001

SECRETARY'S NOTES 2003

PROFESSIONAL NOTES 2005

NOTES ON INTERNATIONAL AFFAIRS 2041

REVIEW OF BOOKS 2048

INDEX TO VOLUME 46 2054

INFORMATION INDEX 2004

OFFICERS OF THE INSTITUTE

President

REAR ADMIRAL BRADLEY A. FISKE, U. S. NAVY

Vice-President

REAR ADMIRAL A. H. SCALES, U. S. NAVY

Secretary and Treasurer

COMMANDER H. K. HEWITT, U. S. NAVY

Board of Control

REAR ADMIRAL BRADLEY A. FISKE, U. S. NAVY (*ex officio*)
REAR ADMIRAL A. H. SCALES, U. S. NAVY (*ex officio*)
CAPTAIN W. T. CLUVERIUS, U. S. NAVY
CAPTAIN A. BRONSON, U. S. NAVY
CAPTAIN T. L. JOHNSON, U. S. NAVY
CAPTAIN E. J. KING, U. S. NAVY
CAPTAIN W. G. DU BOSE, CONSTRUCTION CORPS, U. S. NAVY
COMMANDER B. C. ALLEN, U. S. NAVY
COMMANDER H. K. HEWITT, U. S. NAVY (*ex officio*)

PAST PRESIDENTS

ADMIRAL DAVID D. PORTER, U. S. NAVY, 1873
REAR ADMIRAL JOHN L. WORDEN, U. S. NAVY, 1874
REAR ADMIRAL C. R. P. RODGERS, U. S. NAVY, JAN. 1875–JAN. 1878
COMMODORE FOXHALL A. PARKER, U. S. NAVY, JAN. 1878–JAN. 1879
REAR ADMIRAL JOHN RODGERS, U. S. NAVY, JAN. 1879–JAN. 1882
REAR ADMIRAL C. R. P. RODGERS, U. S. NAVY, JAN. 1882–JAN. 1883
REAR ADMIRAL THORNTON A. JENKINS, U. S. NAVY, JAN. 1883–OCT. 1885
REAR ADMIRAL EDWARD SIMPSON, U. S. NAVY, OCT. 1885–OCT. 1887
REAR ADMIRAL STEPHEN B. LUCE, U. S. NAVY, OCT. 1887–OCT. 1898
REAR ADMIRAL WM. T. SAMPSON, U. S. NAVY, OCT. 1898–OCT. 1902
REAR ADMIRAL H. C. TAYLOR, U. S. NAVY, OCT. 1902–OCT. 1904
REAR ADMIRAL C. F. GOODRICH, U. S. NAVY, OCT. 1904–OCT. 1909
REAR ADMIRAL RICHARD WAINWRIGHT, U. S. NAVY, OCT. 1909–OCT. 1911

WELDED STEEL STEAM AND WATER DRUMS

FOR WATER TUBE BOILERS

Embodying Strength with Lightness and Freedom from Leakages incident to riveted Structures

Morison Suspension Furnaces

Fox Corrugated Furnaces

Welded Steel Tanks, Receivers, etc.

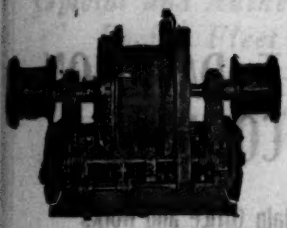
THE CONTINENTAL IRON WORKS

ESTABLISHED 1859
INCORPORATED 1887

West and Calyer Sts. BOROUGH OF BROOKLYN, N. Y
Greenpoint Ferry from East 23rd Street, New York

LIDGERWOOD

Ship's Winches and Steering Engines



IMPROVED DESIGNS

BUILT ON DUPLICATE PART SYSTEM

Improved Metallic Slip Friction Winch

Lidgerwood Mfg. Co., 96 Liberty St., New York

The Marine Corps Score Book

A Rifleman's Instructor

For use in Army, Navy, Marine Corps, National Guard, Naval Militia, Schools and Civilian Clubs.

For beginners, advanced riflemen and rifle teams. For self-instruction and for use in instructing others

It is the boil-down of the shooting game. Its contents are the digest of range practice and experience. Everything in it is practical, easy to learn and easy to teach. It is the last word in accuracy of the art of shooting, instructing and range service.

Supply it to your Company, Club or Team. It will save you labor. Your men will then instruct themselves. Your subordinates can teach it. It will produce results for you with the minimum of work.

Adopted by the War Department and issued by the Ordnance Department to organizations of the Army, and to the Organized Militia (under Sec. 1661 R. S.), and for sale to educational institutions (Bulletin No. 12, 1916, and G. O. No. 1, 1916).

Remittance should accompany order. Stamps accepted for orders less than $1.00

Price, 20 Cents, Post Paid **Discount of 20% on quantities of 50 or more copies**
Delivery Charges Collect

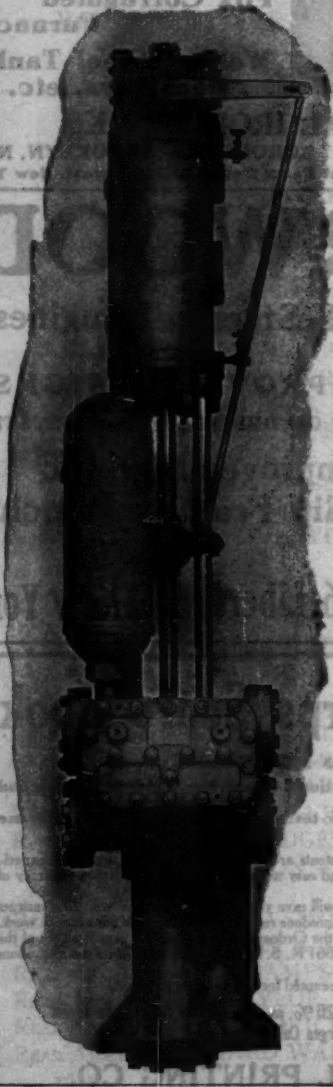
INTERNATIONAL PRINTING CO.

236 Chestnut Street, Philadelphia

DAVIDSON

MARINE PUMPS

FOR ALL SERVICES



USED IN U. S. NAVY SINCE 1882

M. T. DAVIDSON COMPANY

Main Office and Works

43-53 Keap Street
Brooklyn, N. Y.

154 Nassau Street
New York

32 Oliver Street
Boston, Mass.

40,000 NAVY MEN NOW READ

THE NAVAL MONTHLY

(With which is incorporated Pacific Naval Monthly)

ESTABLISHED IN 1911

Published by

NAVAL PUBLISHING COMPANY INC.

OWNED AND OPERATED BY MEN IN THE U. S. NAVAL FORCES

In the Interest of the United States Navy

Official and Authentic European, Atlantic Fleet, Pacific Fleet and Asiatic Navy News

Feature Articles by Naval Writers of Note

Timely Illustrations from the Foremost European and American Photo News Services

To any Address Postpaid $2.00 Per Year

Agents on U. S. Naval Vessels and Stations

NAVAL PUBLISHING COMPANY INC.

207 Bremerton Trust Building
Bremerton, Wash.

307 Chronicle Building
San Francisco, Cal.

83 Columbia Street
Seattle, Wash.

THE SPERRY GYRO COMPASS

¶ THE non-magnetic compass that always points true north, having no variations or deviations.

THE SPERRY HIGH INTENSITY SEARCHLIGHT

¶ THE most powerful automatic searchlight in the world.

¶ Catalogues sent to any naval officer or any executive interested in ship building or ship operation, upon request.

THE SPERRY GYROSCOPE CO.
MANHATTAN BRIDGE PLAZA
BROOKLYN, N.Y.

Reilly Evaporators

Reilly Evaporator
Self Sealing

"For the Best Ships that Float"

THE GRISCOM-RUSSELL CO.
2152 West St. Bldg. - - - NEW YORK
Offices in Principal Cities

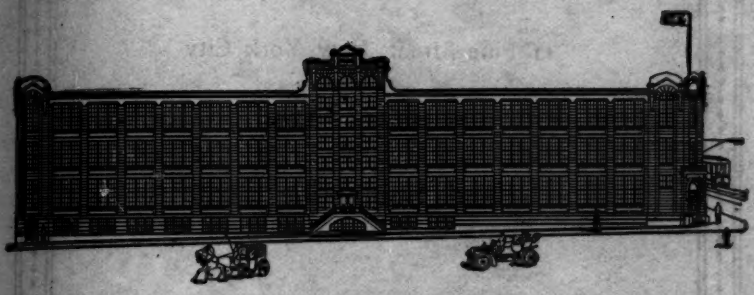
E. S. B. CO. STORAGE BATTERIES

are known for their proved and enduring worth in every field wherever storage batteries can be used in supplying power

They are backed by 32 years of battery building experience

THE ELECTRIC STORAGE BATTERY CO.
The Largest Manufacturer of Storage Batteries in the World
1888 PHILADELPHIA, PA. 1920
New York Boston Washington Minneapolis Denver Detroit
San Francisco Kansas City Chicago Cleveland Atlanta
Pittsburgh St. Louis Rochester

SPECIAL CANADIAN REPRESENTATIVES:
Chas. E. Goad Engineering Co., Limited., Toronto, Montreal



The Lord Baltimore Press

PRINTERS AND
BOOKBINDERS

BALTIMORE, MD., U. S. A.

ELECTRIC BOAT

COMPANY

11 Pine Street, New York City

BUILDERS OF THE

Holland Submarine Boats

McDANIEL IMPROVED STEAM TRAP

Ease of Repair and Minimum of Wear Are Its Strong Characteristics

All working parts are here

Quick and easy to repair

Inlet and outlet connections are connected to the body and need not be broken when making repairs

Send for Complete Catalogue

Watson & McDaniel Company

MANUFACTURERS OF STEAM SPECIALTIES

128 N. SEVENTH ST. PHILADELPHIA, PA.

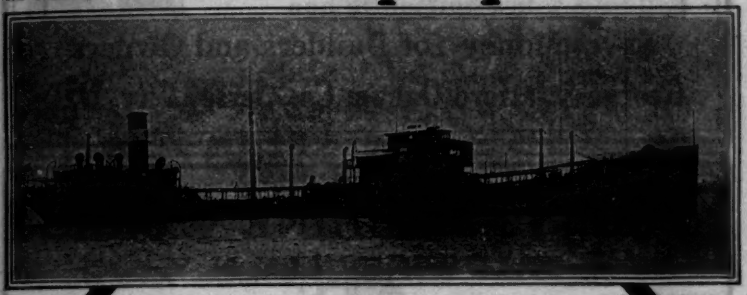
THE STANDARD MODELS OF THE UNDERWOOD ARE WELL KNOWN

We have now brought out a PORTABLE MACHINE that combines the same simple and durable features, which, together with the extreme lightness, makes it the ideal companion of the traveler.

UNDERWOOD TYPEWRITER COMPANY, INC.

1413 NEW YORK AVE., N. W., WASHINGTON, D. C.

Westinghouse
Marine Equipment



S. S. *L. J. Drake*

The tanker *L. J. Drake* was commissioned October 15, 1918, and since that date has a record of practically continuous service. Up to February 15, 1920, she had travelled a distance of 75,000 miles, seldom remaining in port more than 36 hours.

This ship is 8700 tons capacity, 424 feet overall, 54 feet beam, 30 feet depth. She is engined with Westinghouse Cross-Compound Turbines and Double Reduction Gears of 2500 shaft horsepower, the reduction being from 3600 rpm. on the turbines, to 90 rpm. on the propeller. The vessel is driven at a speed of 10½ to 11 knots.

The *L. J. Drake* has averaged 1.00 lb. of oil per shaft horsepower total fuel consumption, including all auxiliaries, heaters, etc.

Those acquainted with the fuel consumption and bunker space required by coal-burning ships propelled by reciprocating engines, will be able to appreciate the marked improvement in economy, dependability, and earning power effected by the use of Westinghouse Geared Turbine Propulsion Machinery.

W
WESTINGHOUSE ELECTRIC

Westinghouse Electric & Mfg. Co.

EAST PITTSBURGH, PA. WASHINGTON, D. C.

Sales Offices in All Large American Cities

Special Pacific Coast Representatives

HUNT, MIRK & COMPANY, SAN FRANCISCO

NOW is the Time for CAULKING, not talking

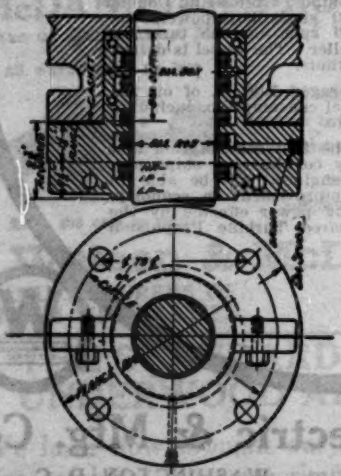
STRATFORD SPECIAL
No. 1 OAKUM

Saves Money for Builders and Owners

George Stratford Oakum Co., Jersey City, N.J.

MORRIS MACHINE WORKS
BALDWINSVILLE, N. Y.

Since 1864 Builders of Centrifugal Pumps, Hydraulic Dredges, and Steam Engines



Metallic Packing

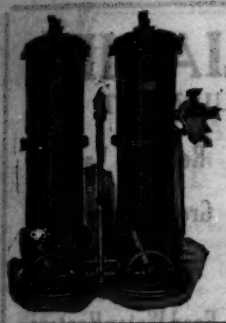
FOR

All Conditions

OF

Marine Service

FRANCE PACKING COMPANY
TACONY, PHILADELPHIA, PA.



Clean, Safe Freshly-filtered Water

Loomis-Manning Filters are a simple and effective means for cleansing and protecting water supplies

Loomis-Manning Filter Distributing Co.

1421 S. 37th Street
Philadelphia, Pa.

ESTABLISHED 1844

A. Schrader's Son, Inc. Manufacturers of **Diving Apparatus**

We make Divers' outfits of all kinds, and invite inquiries from Wreckers, Contractors, Bridge Companies, Water Works, or any one who is thinking of using an Apparatus.

FURNISHER OF
DIVING APPARATUS
TO U. S. NAVY
and
U. S. ARMY ENGINEERS' CORPS

783-791 ATLANTIC AVE. BROOKLYN, N. Y.

Ford Instrument Company, Inc.

(Ford Marine Appliance Corporation)

ENGINEERS AND MANUFACTURERS

80 Lafayette Street, New York

Scientific Instruments — Variable Speed Drive
Automatic Machines — Naval Fire Control Apparatus

The Farmers National Bank of Annapolis, Md.

GROSS ASSETS $2,750,000.00 — ESTABLISHED 1805 — 4% INTEREST ON SAVINGS ACCOUNTS

STORAGE VAULTS — SAFE DEPOSIT BOXES

HERMAN COHN 45 Sands St., Brooklyn, N. Y.
ESTABLISHED 1890 — 712 Crawford St., Portsmouth, Va.

Mail Orders for Navy Uniforms and Equipment Promptly Attended to

Write for price list and measurement blanks

MARINE AUXILIARIES

COMPLETE OIL FIRING EQUIPMENT

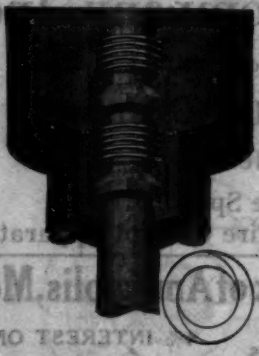
Injectors
Bilge Syphons
Oil Coolers
Oil Heaters
Oil Strainers
Hydrokineters
Throttle Valves

Reducing Valves
Grease Extractors
Thermofans
Feed Water Heaters
Distillers
Evaporators
(Navy Type)

SCHUTTE & KOERTING CO.

1194 THOMPSON STREET

PHILADELPHIA, PENNA.



KING RING
IN TWO PARTS

KING METALLIC PACKING

FOR

ALL PRESSURES

THE U. S. METALLIC PACKING CO.

NEW YORK—PHILADELPHIA—CHICAGO

DU PONT

A New and Better

PISTOL POWDER

OUT of the war comes a new Pistol Powder developed from the experience the powder industry gained during those four years. Du Pont Pistol Powder No. 5, a nitrocellulose smokeless powder, is so clean burning, easy shooting and accurate that it is a perfect and dependable load for all revolvers and automatic pistols. It ranks with other Du Pont Powders which for 118 years have stood the test of government use, a fact which proclaims their worth.

E. I. du Pont
de Nemours & Co., Inc.
Military Sales Division
Wilmington, Del.

TRADE **TOBIN BRONZE** MARK

Registered in U. S. Patent Office

Non-Corrosive in Sea Water. Readily Forged at Cherry Red Heat

Round, Square and Hexagon Rods for Bolts and Rivets. Finished Pump Piston Rods, Valve Stems and Motor Boat Shafting, ready for fittings. Rolled Plates for Pump Linings, and Condensers. Descriptive pamphlet giving tests furnished on application.

THE AMERICAN BRASS COMPANY

ANSONIA BRANCH, ANSONIA, CONN., SOLE MANUFACTURERS

The Annapolis Banking & Trust Company

CORNER MAIN STREET AND CHURCH CIRCLE

Capital, $100,000.00 Resources, $1,500,000.00

WE MAKE A SPECIALTY OF NAVAL BUSINESS

F. HOWARD THOMPSON, JR., Treasurer JAMES A. WALTON, President

THE INSTITUTE BOOK DEPARTMENT

WILL FILL ORDERS FOR OBTAINABLE BOOKS OF ALL KINDS, FURNISHING THEM AT RETAIL PRICES, POSTAGE PREPAID.

Unexcelled designing and manufacturing resources, coupled with large productive facilities, insure accuracy of detail and over-all excellence.

36-inch Searchlight on Station near New Mexico, "The Electric Sky."

The Spur of Necessity

THE co-ordinating of human effort, stimulated and made possible by war-time necessity, resulted in the extremely rapid development of the searchlight. In this period the General Electric Company made sound improvements in their various models and also developed many new ones--the number of parts was reduced, the weight and cost lessened and the power and mobility increased.

Today rugged G-E searchlights are equal to any service--marine, mining, construction--reflecting not only the powerful light they generate but less obviously the intense scientific study and manufacturing skill that have made them what they are.

They are made in many sizes and with various types of control. Bulletin 43856-A. which tells their story is ready for all who ask for it.

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

30-11

Keds

Ideal Shoes For Naval Wear

Officers of the Navy have long been seeking satisfactory footwear to match their "whites." Something that is light, cool and comfortable—flexible, easy on the feet, springy and durable. If this is the sort of footwear you need, try a pair of KEDS.

KEDS are made of sturdy fabric uppers and resilient rubber soles in both bals and oxfords.

There are many varieties of KEDS to suit your every need—for duty, sport, or on shore leave. KEDS with the welt form of construction have all the smartness of leather shoes. KEDS are ideal for summer wear and all year service in the tropics.

Write us at 1790 Broadway for your nearest dealer, or ask your supply officer.

United States Rubber Company

Please mention the PROCEEDINGS when writing advertisers

U. S. NAVAL INSTITUTE
PROCEEDINGS
Number 214